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TECHNICAL REPORT 21

New Mexico State Engineer
Santa Fe, N. Mex.

AVAILABILITY OF GROUND WATER IN THE ALBUQUERQUE AREA, BERNALILLO AND SANDOVAL COUNTIES, NEW MEXICO

By

Louis J. Bjorklund and Bruce W. Maxwell

Prepared in cooperation with the United States Geological Survey

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Aerial view of a part of the city of Albuquerque, N. Mex. (looking to the east). The Rio Grande is in the foreground. Immediately beyond the river is the densely populated downtown commercial-industrial area, occupying the inner valley or flood plain of the river, once the site of fertile farms. Beyond the inner valley are the more recently developed "heights" and "east mesa" areas and the cloud-capped Sandia Mountains. Arrows indicate the east boundary of the inner valley. --Photograph (1960) by Dick Kent, Albuquerque.

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1961

Printed
by
Reports Section
Technical Division
State Engineer Office
Santa Fe, New Mexico
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CONTENTS

ILLUSTRATIONS

ILLUSTRATIONS (continued)

TABLES

AVAILABILITY OF GROUND WATER IN THE ALBUQUERQUE AREA, BERNALILLO AND SANDOVAL COUNTIES, NEW MEXICO

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Louis J. Bjorklund and Bruce W. Maxwell

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ABSTRACT

The Albuquerque area includes about 1,400 square miles in Bernalillo and Sandoval Counties, N. Mex. It extends from Algodones and the north side of the Jemez River valley on the north to Isleta and the Valencia County line on the south and from the Sandia and Manzano Mountains on the east to the Rio Puerco on the west. Albuquerque, the center of population, was established in 1706; between 1940 and 1960 the city grew from 35,449 to about 200,000 residents.

Water diverted from the Rio Grande has been a mainstay of life for hundreds of years in the Albuquerque area. The Middle Rio Grande Conservancy District integrated the many diversion systems into a workable unit between 1927 and 1935 and constructed an extensive drainage system which greatly improved the water facilities. The State Engineer in 1956 declared the Rio Grande Underground Water Basin to protect the surface- and ground-water resources from being overdeveloped.

The Albuquerque area lies mostly within the Rio Grande depression, which is a series of grabens and structural basins having a general north-south alinement and which is bordered on the east and west by upfaulted blocks. Igneous, metamorphic, and sedimentary rocks exposed in the Albuquerque area range in age from Precambrian to Quaternary. Rocks older than Tertiary are exposed in the Sandia and Manzano Mountains to the east and in the Rio Puerco valley and on the highlands west of the Zia Indian Reservation. These older rocks yield relatively small quantities of water to wells in the area.

The grabens or valleys have been filled partly by sand, gravel, silt, clay, and volcanic rocks of Tertiary and Quaternary age. In places the sediments, which are unconsolidated to loosely cemented, are more than 6,000 feet thick. All water wells of large capacity are finished in the sedimentary rocks.

Ground water in the valley fill generally occurs under water-table conditions. Sediments east of the inner valley generally are more permeable than sediments underlying or west of the inner valley. Coefficients of transmissibility determined at tested wells in the valley fill ranged from 7,500 to 600,000 gpd (gallons per day) per foot, and average permeabilities at wells ranged from 13 to 840 gpd per square foot.

Water is pumped from wells for public, irrigation, industrial, commercial, domestic, and stock uses. Wells of large yield usually are drilled at least 200 feet into water-bearing material. The specific capacity of most large-discharge wells ranges from 20 to 100 gpm (gallons per minute) per foot of drawdown and the average specific capacity of 66 selected wells was 44 gpm per foot. The municipal water system of the city of Albuquerque is supplied from 77 wells ranging in depth from 65 to 1,284 feet. The average daily pumpage in Albuquerque increased from 2 mgd (million gallons per day) in 1930 to 34 mgd in 1959. The town of Bernalillo is supplied by two wells. Several schools, hotels, hospitals, public buildings, and government installations in and near Albuquerque are supplied with water from privately and institutionally owned wells. Many industries and commercial institutions obtain their water from privately owned wells. Large-discharge irrigation wells are used on farms, both as a sole source of water and to supplement existing surface-water supplies. Many small-discharge driven irrigation wells are used to irrigate small farms and gardens. The total pumpage in the area in 1959 was about 63,000 acre-feet.

The water table slopes diagonally downvalley from the bases of the Sandia and Manzano Mountains on the east and from the Rio Puerco on the west toward a ground-water depression, or "trough," about 8 miles west of the Rio Grande. The trough extends southward into Valencia County. A ground-water mound masks the trough beneath the Jemez River valley. The water table beneath the inner valley slopes southward at approximately the same gradient as the river. Another ground-water depression has been formed near downtown Albuquerque by pumping from wells.

Water levels beneath the inner valley have lowered significantly since drains were constructed in 1930. Ground-water levels have declined beneath downtown Albuquerque and in a few other centers of heavy pumping. Levels will decline further in the Albuquerque area if the annual pumping rate increases, but will stabilize at some lower level within a few years after the annual pumping rate becomes constant.

The depth to water below the land surface in most of the inner valley is between 5 and 10 feet but beneath downtown Albuquerque it is as much as 29 feet. The depth to water beneath the "east mesa" increases eastward to as much as 600 feet, and beneath the "west mesa" it increases westward to as much as 1,000 feet. Depths to water in the Jemez River valley are shallow but increase northward and southward from the river.

The ground-water reservoir is recharged by infiltration of precipitation; by seepage from streams, drains, canals, and surface reservoirs; by infiltration of applied irrigation water; and by underflow of ground water from adjacent areas. Much water seeps to the ground-water reservoir from the Rio Grande and the Jemez River, and from ephemeral streams, especially in the upper parts of alluvial fans near the mouths of canyons. Drains contribute water to the ground-water reservoir in places where the water table is lower than the drains. Probably about a third of the water pumped from wells for irrigation returns to the ground-water reservoir. Rates of seepage from two wetted land-surface areas on the west mesa were 2.6 and 1.6 acre-feet per acre per day. Rates of seepage from pits were 10 to 13.7 acre-feet per acre per day.

Water is discharged from the ground-water reservoir through springs and seeps, drains, and wells, and by evapotranspiration. Many small springs discharge into canyons and arroyos along the face of the Sandia and Manzano Mountains, but this water either is evaporated and transpired or returns to the ground-water reservoir to be discharged elsewhere. About 100 miles of drains prevent the waterlogging of land on the valley floor. About 18 square miles of the inner valley is covered with cottonwood, willow, and saltcedar which use an average of about 4 acre-feet of water per acre per year.

Water in the area is chemically suitable for most uses, although surface waters usually contain suspended sediments. Of 68 ground-water samples collected from sediments of Tertiary age, 61 were fresh, 6 were slightly saline, and 1 was moderately saline. Water in sediments of Quaternary age usually is more mineralized than water in the older valley fill. The chemical quality of water in deposits of Quaternary age has improved since the construction of drains in 1930. The chemical quality of water in the Rio Grande is good.

The temperature of water in wells in the Albuquerque area ranges from 51° to 90°F. The low temperatures are attributed to recharge of cold water from streams. The causes of the higher temperatures are not known but may be volcanism or faulting.

INTRODUCTION

Location and Extent of the Area

The Albuquerque project area of this report is in the middle section of the upper Rio Grande basin, mostly in the "Middle Valley" of the Rio Grande as defined by the National Resources Committee (1938, Regional Planning, Part IV - The Rio Grande Joint Investigation, p. 7). It includes about 1,400 square miles in Bernalillo and Sandoval Counties, N. Mex. (fig. 1). The northern, or upstream, edge of the project area is at Algodones, and along the north side of the Jemez River valley, in Sandoval County; the south edge is at Isleta and the south boundary of Bernalillo County, 12 miles south of

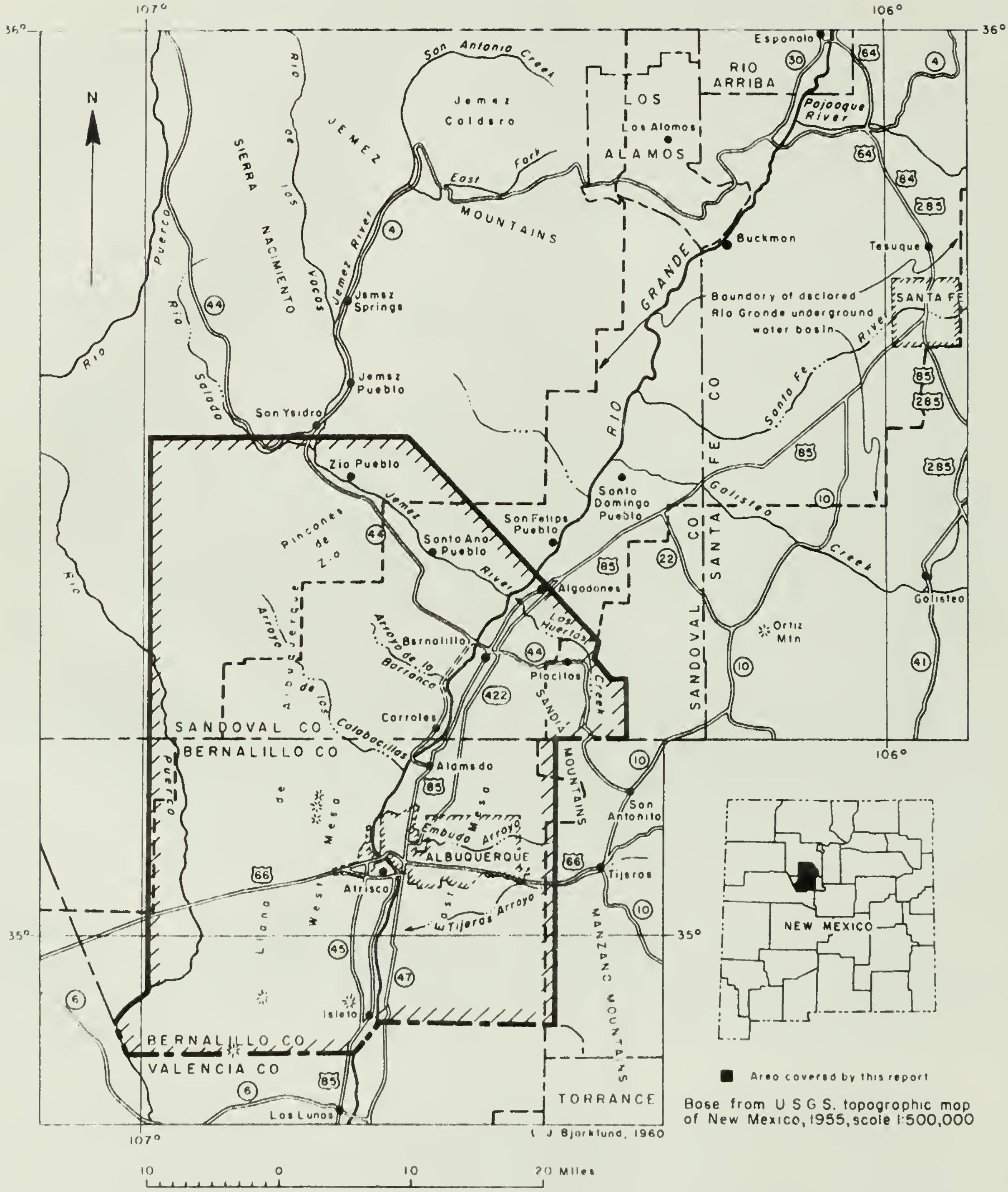


FIGURE 1. -- Index map of the Albuquerque area, Bernalillo and Sandoval Counties, N. Mex.

Albuquerque. The most intensively investigated part of the area is about 26 miles wide and extends westward from the Sandia and Manzano Mountains through Albuquerque to the Rio Puerco. The northern part of the area extends westward to the divide between the Rio Grande and the Rio Puerco.

Purpose and Scope

The rapid population growth of the city of Albuquerque and of nearby localities created a need for more information about the water-bearing formations that are the source of supply for the city, the military, and industrial installations, and the suburban areas. Most of the farms in the area use surface water for irrigation, but some depend upon wells as a supplementary source of water; a few farms depend upon ground water exclusively. A knowledge of the water resources is necessary for the city to plan for the future, and for the State Engineer to administer the use of water in the Rio Grande valley.

The investigation was made to determine the source, quality, movement, and dependability of the ground-water resources, and to determine the effects of the use of ground and surface waters on the ground-water body and the flow of streams, particularly the Rio Grande. This report describes only the general hydrologic conditions. A later report will discuss in more detail the quantitative aspects of the ground-water supply.

The geology of the area was studied to determine the extent and composition of the valley fill, which contains the principal aquifers, and to locate faults, folds, and other geologic features that have a bearing on the occurrence, movement, and quality of ground water.

The study was made by the U. S. Geological Survey in cooperation with the State Engineer of New Mexico and the city of Albuquerque, under the general direction of A. N. Sayre and P. E. LaMoreaux, former and recent chiefs of the Ground Water Branch. W. E. Hale, district engineer in charge of ground-water investigations in New Mexico, supervised the work. The collection of basic geologic and hydrologic data was started in September 1955 by B. W. Maxwell, geologist. L. J. Bjorklund, engineer, joined the project in July 1956.

Previous Investigations

The geology and physiography of the Albuquerque area and areas in and adjacent to the Rio Grande depression have been described by many investigators. The reports most pertinent to this study are those by Bryan (1938), Bryan and McCann (1936, 1937, 1938), Cabot (1938), Smith (1938), Denny (1940), Wright (1943, 1946), Stearns (1943, 1953a,b), and Spiegel and Baldwin (1958). All these reports describe the Tertiary and Quaternary geology of the Rio Grande depression and include comprehensive discussions of the Santa Fe group, the most important aquifer.

The description of pre-Tertiary stratigraphy and geologic history in this report are adapted largely from the work of others in areas bordering the Rio Grande depression. Important studies were made by Sears, Hunt, and Dane (1936), Read (1945), Kelley and Wood (1946), Wood and Northrop (1946), Reiche (1949), and Kelley (1952). The pre-Tertiary rocks do not contain the principal aquifers; rather, they define the limits of aquifers in the younger rocks and affect the runoff in the area.

The occurrence of ground water in the Rio Grande valley near Albuquerque was investigated by Lee (1907), Bloodgood (1930), and Theis and Taylor (1939). Bryan (1938) and Theis (1938) wrote sections of a comprehensive report on the geology and water resources of the Middle Valley for the National Resources Committee.

Methods of Investigation

In the course of this investigation, records were obtained for 118 irrigation wells, 107 industrial wells, 79 municipally owned wells, and 106 wells and springs used for domestic and stock purposes (tables 1, 2, 3, and 4). Most of the wells in the area that discharge more than 200 gpm were included in the inventory. Many drive-point irrigation wells of low capacity were recorded, but detailed data on these wells were not collected. Tenants, well owners, and drillers in the area were interviewed. Available well logs and detailed hydrologic and geologic information were collected and studied. Depths to water and depths of wells were measured with steel tapes, and the rates of pump discharge were either estimated or measured. Depths to water were measured periodically in 38 wells to observe fluctuations of the water table. Records were obtained from six recording gages operated by the city of Albuquerque on wells in the city well fields that were specifically constructed as observation wells. Drawdown and recovery of water levels in several pumped wells were measured to determine the aquifer characteristics.

The locations of the wells described in the report are shown on plates 2a and 2b. The altitude of the land surface at the wells was determined from topographic maps published by the Geological Survey.

Well-Numbering System

The system of numbering wells and locations in this report is based on the common subdivision of public lands into townships, ranges, and sections. A number designates a well or observation point, and locates its position to the nearest 10-acre tract in the land network.

The location number is divided by periods into four segments. The first segment denotes the township north of the New Mexico base line. The second segment denotes the range east or west of the New Mexico principal meridian. The third segment indicates the number of the section within the township. The fourth segment indicates the 10-acre tract in which the well is situated. The section is divided into four quarters, numbered 1, 2, 3, and 4, in normal reading order. The first digit of the fourth segment gives the quarter section. Similarly, the quarter section is divided into four 40-acre tracts numbered in the same manner, and the second digit denotes the 40-acre tract. Finally, the 40-acre tract is divided into four 10-acre tracts, and the third digit denotes the 10-acre tract. Thus, a location numbered 10.3.24.342 would be in the NE¼SE¼SW¼ sec. 24, T. 10 N., R. 3 E. (fig. 2).

If a well is situated west of the New Mexico principal meridian the letter "W" is added to the second segment of the well number, as in 10.3W.10.324. If a well cannot be located accurately to a 10-acre tract, a zero is used as the third digit of the fourth segment, and if it cannot be located accurately within a 40-acre tract, zeros are used for both the second and third digits. If it cannot be located more closely than the section, the fourth segment of the well number is omitted. The letters a, b, c, etc., are added to the last segment to designate the second, third, fourth, and succeeding wells in the same 10-acre tract. For springs the letter "S" is added as a prefix to the location number.

Where the land has not been sectionized, as in Spanish land-grant areas, lines were projected from the sectionized land through the grant lands to form a grid representing townships, ranges, and sections; these projected sections are shown by dashed lines on plates 1a, 1b, 2a, 2b, 3a, and 3b.

In highly developed areas the wells were located also with reference to prominent landmarks, such as street and road intersections, bridges, and railroad crossings. These references are given in the "Remarks" column of the tables of well records (tables 1, 2, 3, and 4).

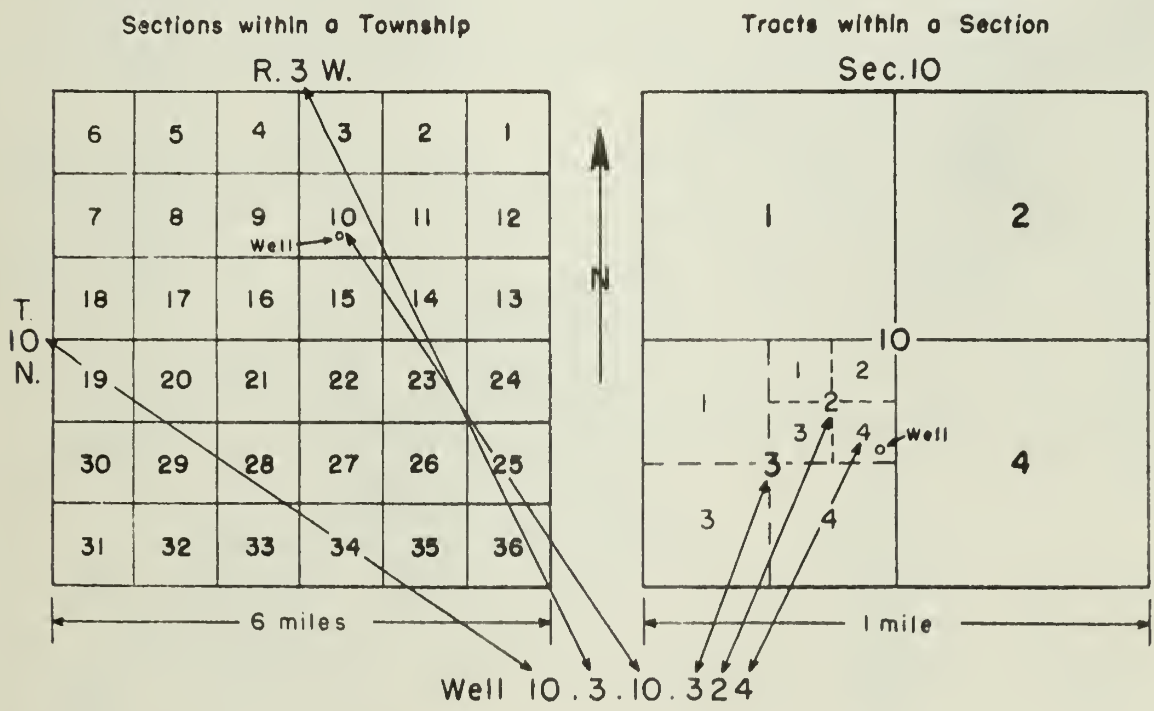


Figure 2.-- System of numbering wells in New Mexico.

Acknowledgments

The cooperation of residents of the area and of officials of Federal, State, municipal, and industrial establishments in giving information and permitting tests and measurements of wells is gratefully acknowledged. The city of Albuquerque furnished detailed data on 85 municipally owned wells and recording-gage data on 6 wells. Through arrangements with the city, samples of water from municipally owned wells were collected for chemical analysis and pumping tests were made on several city wells. Gordon Herkenhoff and Associates, Inc., consulting engineers, contributed data collected in well-performance tests of wells drilled for the city. The Middle Rio Grande Conservancy District furnished detailed information regarding canals and drains in the Middle Valley. The New Mexico State Engineer contributed logs of wells.

GEOGRAPHY

Physiography and Drainage

The Albuquerque area is in the Mexican Highland section of the Basin and Range province (Fenneman, 1931), south of the Southern Rocky Mountain province and southeast of the Colorado Plateau province. The area is drained by the Rio Grande system, which begins in Colorado and flows southward to become the international boundary between the United States and Mexico. The Rio Grande valley from the Colorado-New Mexico line to the New Mexico-Texas line is a long narrow structural depression bordered by uplands -- a rift valley. For the purpose of this report that part of the Middle Valley in which the Rio Grande flows and which is underlain by Recent alluvium will be called "the inner valley" and its surface will be referred to as "the inner valley floor" (fig. 3) or as the "valley floor" (tables 1, 2, 3, and 4).

The Sandia and Manzano Mountains border the Rio Grande valley on the east. The sloping surface of the valley fill from the base of the mountains to the Rio Grande is referred to locally as the "east mesa." The slope of the east mesa near the mountains is about 250 feet per mile; near the river the slope is about 20 feet per mile. The distance between the base of the mountains and the east edge of the inner valley ranges from about 3 miles in the northern part of the area to about 9 miles in the southern part. The inner valley is relatively flat and ranges in width from 1 to 4 miles. It is separated from the east mesa by a bluff which is breached by arroyos from which alluvial fans spread out on the inner valley floor.

A series of cut terraces parallel the Rio Grande on the west. A broad upland called the Llano de Albuquerque about 600 feet above the river (fig. 1) borders the cut terraces on the west. The Llano together with the cut terraces is called the "west mesa" in the vicinity of Albuquerque. The Llano de Albuquerque is about 70 miles long and 8 to 12 miles wide (Wright, 1946, p. 439). The Llano slopes generally southeastward at about 50 to 100 feet per mile. Small volcanic cones, west

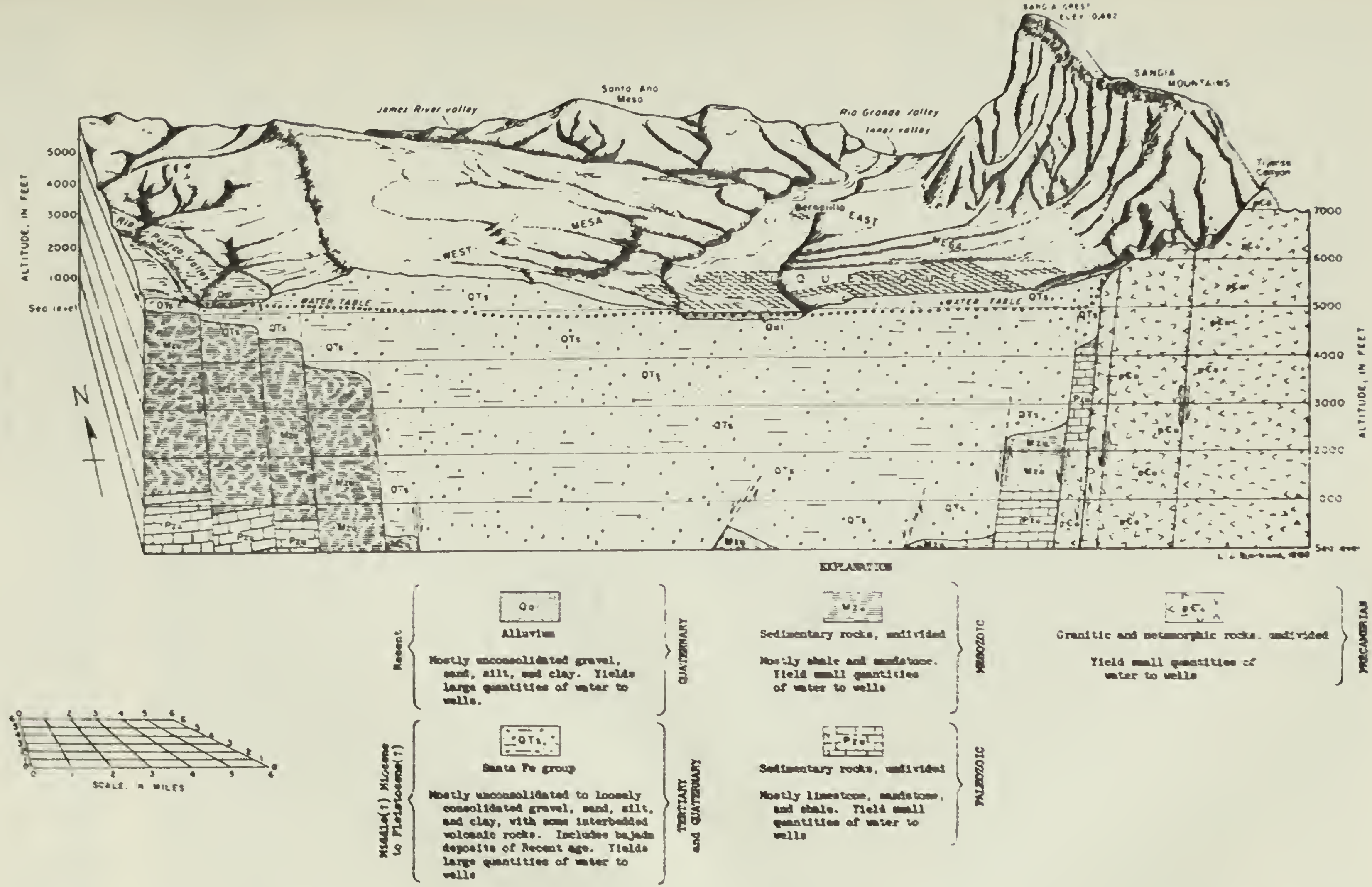


FIGURE 3. -- Block diagram of an area 33 miles square near Albuquerque, Bernalillo and Sandoval Counties, N. Mex., showing topography, generalized geology, and the water table in the alluvium and the Santa Fe group.

of Albuquerque and Isleta, rise prominently above the general surface of the Llano. Near these cones are several closed depressions. A row of dunes along the west edge of the Llano de Albuquerque is called the Ceja del Rio Puerco (pls. 1a and 1b) (Wright, 1946, p. 439).

The project area is drained by one perennial stream, the Rio Grande, and many ephemeral tributaries (fig. 1). The Jemez River, the largest tributary in the area, flows from the Jemez caldera southeastward into the Rio Grande near Algodones. The Rio Puerco in the western part of the project area flows southward, and enters the Rio Grande about 50 miles downstream from Albuquerque. Many arroyos drain the mesas; those on the west side of the Rio Grande north of Arroyo de la Barranca discharge directly into the river; those south of Arroyo de la Barranca and those on the east side of the river discharge into canals or drains or lose their flow by infiltration into alluvial fans before reaching the river. Las Huertas Creek and Tijeras Arroyo, the largest tributaries to enter the Rio Grande from the east, drain a part of the east slopes as well as the west slopes of the Sandia and Manzano Mountains. Between these two tributaries are numerous arroyos that originate on the west front of the mountains and flow westward across the east mesa into the inner valley. Arroyos west of the Ceja del Rio Puerco flow westward into the Rio Puerco and those in the Rincones de Zia flow northward into the Jemez River.

Climate

Sunny days, large daily temperature changes, low humidity, and scant rainfall are characteristic of the Rio Grande valley in the vicinity of Albuquerque. Midday summer temperatures often approach and sometimes exceed 100°F, but nights are cool. Midday winter temperatures usually are mild and the nights are moderately cold, usually from 1° to 15° below freezing.

Climatological data were collected at Albuquerque at intervals from 1850 to 1892 and have been collected every year since 1892. The average annual precipitation for the 66-year period 1892-1957 was 8.08 inches; average precipitation for the 30-year period 1921-50 was 8.68 inches.

Most precipitation at Albuquerque occurs during localized thundershowers which sometimes are torrential and cause floods. About 45 percent of the precipitation occurs during July, August, and September, whereas only about 12 percent occurs during January, February, and March. Most of the summer moisture enters the area in air masses moving from the Gulf of Mexico, but most of the winter moisture moves into the area from the Pacific Ocean. The following table shows the average monthly precipitation in inches at Albuquerque for the period 1921-50.

Average Monthly Precipitation at Albuquerque, in Inches

Jan.	0.28	Apr.	0.53	July	1.43	Oct.	0.64
Feb.	.33	May	.87	Aug.	1.38	Nov.	.42
Mar.	.44	June	.72	Sept.	1.05	Dec.	.59
					Annual		8.68

The precipitation at Albuquerque supports grass and brush but is not sufficient for crops. Crops must be irrigated with water diverted from the Rio Grande or pumped from wells. The annual precipitation in the higher parts of the Sandia and Manzano Mountains east of Albuquerque, and in the Jemez Mountains to the north, averages about 30 inches.

Temperatures on the mesas are usually several degrees higher than on the inner valley floor, and the growing seasons on the mesas are longer. The average annual temperature at the weather station at the Albuquerque airport on the east mesa (altitude 5,310 feet) is 56.6°F; at the Experimental Farm Weather Station on the valley floor in sec. 12, T. 9 N., R. 2 E. (altitude 4,928 feet), it is 53.8°F. The average frost-free period at the airport is 206 days (Apr. 9 - Oct. 31), but at the Experimental Farm it is only 168 days (Apr. 25 - Oct. 9). The Sandia and Manzano Mountain areas east of Albuquerque are colder than the adjacent Rio Grande valley. The Tijeras Ranger Station (altitude 6,300 feet) in the Manzano Mountains has an average of 134 frost-free days per year (May 20 - Oct. 1).

Cultural Development

The Albuquerque area is a rapidly growing community having a population of about 260,000 in 1960. It has several large Federal government installations and offices of numerous Federal and State agencies, a farming and livestock industry, a thriving tourist trade, a State university, and many smaller institutions and industries; it is a focal point for railroad, highway, and air traffic.

The original townsite was established in 1706 on the inner valley floor near the Rio Grande. The community grew slowly, and in 1860 and 1870 it included slightly more than 1,000 people. The growth was accelerated in 1880 when the Santa Fe railroad was built to the town. Between 1880 and 1940 the population increased steadily from 2,315 to 35,449. Growth has been rapid since 1940; the population by 1950 was 97,012 and in 1960 was about 200,000. During the period 1940-60 the city spread over large areas of the valley floor and of both the east and west mesas. Today (1960), most of the population is on the east mesa.

Water Management

Water diverted from the Rio Grande to irrigate crops has been a mainstay of life in the valley for hundreds of years. Before the Spanish conquistadores came into the valley the Indian Pueblo dwellers farmed the lowlands near the river where water was easily accessible. Spanish colonizers later followed the same practice, and the irrigation systems were extended and expanded as the population increased.

Shortages of water developed in the Mesilla and El Paso valleys during the early 1890's, and the irrigators in Mexico, near Juarez, alleged that the shortages were caused by increasing diversions from the river upstream. The complaints resulted in the embargo of 1896 and the Mexican Treaty of

1906. The embargo was an order by the Secretary of the Interior that suspended applications for rights-of-way for irrigation canals across public lands in the Rio Grande valley in New Mexico and Colorado. It effectively prohibited the use of Rio Grande water for additional large irrigation developments. The Treaty of 1906 guaranteed to Mexico 60,000 acre-feet of water annually at the point of diversion -- with the provision that "in case of extraordinary drought or serious accident to the irrigation system in the United States, the amount delivered to the Mexican canal shall be diminished in the same proportion as the water delivered to lands under said irrigation system in the United States." Elephant Butte Dam was constructed in 1916 partly to develop a reclamation project and partly to insure fulfillment of the Mexican Treaty.

The Middle Rio Grande Conservancy District was organized in 1927 to improve the irrigation, drainage, and flood-protection facilities of the Rio Grande valley from White Rock Canyon to Bosque del Apache, a distance of 155 miles. The Albuquerque division of the Conservancy District extends from near Algodones to Isleta and in north-south dimension almost coincides with the Albuquerque project area of this report.

The Conservancy District integrated into a workable, dependable unit the many small diversions from the Rio Grande that were operated by individuals and communities. Unnecessary diversion dams were eliminated and the remaining dams were improved. Today one diversion dam near Algodones and a supplementary diversion at Albuquerque supply the needs for the Albuquerque division, whereas between 10 and 20 dams had previously been used (Hubert Ball, Middle Rio Grande Conservancy District, oral communication, 1960).

Drains were designed and constructed by the Conservancy District during 1931-35 to control the waterlogging of irrigated lands. So much water from irrigation had percolated into the ground that the ground-water levels rose to or near the land surface almost everywhere in the inner valley. Bloodgood (1930, p. 54-60) pointed out that the average depth to water in several hundred observation wells in the Middle Rio Grande valley was 2.50 feet and that the average depth to highest water, which usually occurred in May, was 1.30 feet. He pointed out also that in 1919 about 28 percent of the area of the valley floor was covered by salt grass and alkali, or was swampland (Bloodgood, 1930, p. 5). Today waterlogging and the formation of alkali on the Rio Grande valley floor within the project area are virtually absent, owing to the effectiveness of the Conservancy District drains; also, through the draining of the land, a large quantity of water is being salvaged for beneficial use.

The Rio Grande Underground Water Basin was established by the State Engineer on November 29, 1956; since that date the area included in the basin has been under the jurisdiction and administration of the State Engineer, insofar as the development of ground-water resources is concerned. The basin is the largest of the State's declared underground water basins and includes most of the Rio Grande valley from the Colorado line to Elephant Butte Dam. The basin was declared to protect water rights from impairment by uncontrolled use and development of ground water.

The State Engineer's order creating the basin stated that surface waters of the Rio Grande system in New Mexico are fully appropriated and that surface and ground waters in the basin are interrelated parts of a single supply (Reynolds, 1958, p. 21-28). Withdrawals of ground water thus are placed in the same category as diversion of water from the river and are, therefore, subject to similar rules of appropriation.

The development of supplemental ground water to serve existing surface-water rights is permitted and new appropriations of ground water are allowed, provided that the immediate and ultimate effects on the flow of the river are offset by the retirement of existing water rights.

Changes in the point and method of diversion and in the location and type of use are permitted if the changes do not impair the rights of others. Thus, the water rights may be transferred from surface water to ground water. Similarly, the use of water may be changed from agricultural to municipal or industrial use.

GEOLOGY

Igneous, metamorphic, and sedimentary rocks are exposed in the vicinity of Albuquerque (see page 14). The igneous and metamorphic rocks are mostly granite and metamorphosed clastic rocks of Precambrian age, and basaltic-flow rocks of Tertiary age. The rocks of Precambrian age are exposed in the Sandia and Manzano Mountains, where they are overlain by a thick sequence of sedimentary rocks of marine and continental origin which range in age from Early Pennsylvanian to Recent. The basaltic rocks occur as flows on the west mesa, and as interbeds with stream sediments of Quaternary age west of the Rio Grande. The surficial geology of the area, with special emphasis on Tertiary and Quaternary deposits, is shown in plates 1a and 1b.

Geologic History

Sedimentary rocks of marine and continental origin in the Rio Grande valley are underlain by crystalline rocks which were deformed, intruded by granite, metamorphosed, uplifted, and eroded before Cambrian time. By late Precambrian or early Paleozoic time the region had been reduced to a peneplain (Reiche, 1949, p. 1198), and the sea was advancing over the land. From Early Pennsylvanian through Permian time the area was alternately covered by a shallow sea and elevated above sea level, and 2,000 to 5,000 feet of limestone, siltstone, sandstone, and some gypsum were deposited in the alternating marine and continental environments.

Continental deposition was continuous through most of the Mesozoic era. During Triassic, Jurassic, and Early Cretaceous time, continental sandstone and shale were deposited, but during Late Cretaceous time the sea again covered the region and marine sandstone and shale were deposited. Toward the close of the Cretaceous period, or early in the Tertiary period,

GENERALIZED SECTION OF GEOLOGIC FORMATIONS IN THE ALBUQUERQUE AREA, BERNALILLO AND SANDOVAL COUNTIES, N. MEX.

Era	System	Series		Unit	Thickness (feet)	Lithology	Water-bearing characteristics
Cenozoic	Quaternary	Recent		Alluvium	0 to 120±	Cobbles, gravel, sand, silt, and clay, unconsolidated. Generally underlies valley floor.	Yields large quantities of water of good to fair quality to irrigation, industrial, stock, and domestic wells. Water generally has a high silica content.
				Bajada deposits	0 to 200±	Boulders, cobbles, gravel, sand, and silt, consisting of fragments of feldspar, quartz, and igneous and metamorphic rocks, unconsolidated to loosely consolidated.	Generally lie above the water table except along the mountain front at the contact with pre-Tertiary rocks. Yield some water to contact springs and may yield water to a few domestic and stock wells.
		Pleistocene (?)		Santa Fe group	0 to 6,100+	Boulders, cobbles, gravel, sand, silt, and clay, unconsolidated to consolidated but generally weakly cemented, includes interbedded volcanic material locally.	Yields large quantities of water of good quality to municipal, industrial, irrigation, stock, and domestic wells. Water generally has a high silica content.
	Tertiary	Miocene (?)					
		Eocene		Espinaso volcanic rocks of Stearns (1943)	400 to 1,400	Breccia, conglomerate, and tuff.	Deeply buried if present, no wells are known to be completed in this formation.
		Eocene and Oligocene (?)		Galisteo formation	900 to 4,000	Sandstone, sand, clay, and shale.	Do.
Mesozoic	Cretaceous	Upper		Mesaverde group	1,500 to 2,000	Predominantly gray to black shale, includes several prominent beds of buff-colored to gray sandstone and some thin beds of coal.	No wells tap this unit because of great depth. Sandstone beds yield water of fair to poor quality to stock and domestic wells in adjoining areas.
				Mancos shale	900 to 2,500	Predominantly gray to black shale; includes several beds of buff-colored to gray sandstone.	Do.
		Lower	Zuni sandstone	Dakota sandstone	75 to 110	Sandstone, buff to tan; interbedded shale.	Do.
	Jurassic	Upper	Zuni sandstone	Morrison formation	210 to 660	Shale, green, pink, gray, and maroon, and white and buff sandstone members.	Do.
			Zuni sandstone	Bluff sandstone	100 to 140	Sandstone, buff.	Do.
			Zuni sandstone	Summerville formation	60 to 120	Sandstone and sandy shale, red to gray.	Do.
			Zuni sandstone	Todilto limestone	40 to 250	Two beds of limestone separated by a thick bed of gypsum.	Buried deeply; yields little or no water. Water has a high sulfate content.
			Zuni sandstone	Entrada sandstone	160 to 220	Sandstone, cross-bedded, red to gray.	Buried deeply; yields water to stock and domestic wells in adjoining areas. Quality of water generally poor because of high sulfate concentration.
	Triassic	Upper		Chinle formation	1,100	Shale, red, and channel deposits of shaly sandstone; contains beds of red sandstone at top and bottom.	Buried deeply; yields no water to wells. Sandy zones yield water to domestic and stock wells in adjoining areas. Quality of water generally is poor.
Paleozoic	Permian			San Andres limestone	47 to 470	Interbedded limestone, gypsum, and sandstone.	Buried deeply; yields water to stock and domestic wells in adjoining areas.
				Glorieta sandstone	70 to 220	Sandstone, fine-grained, buff to white, contains gypsum in some areas.	Do.
				Yeso formation	400 to 1,100	Sandstone and siltstone, tan-brown to red.	Buried deeply; yields little or no water to wells.
				Abo formation	810 to 900	Sandstone, fine- to coarse-grained, and siltstone; red to gray.	Buried deeply, yields small quantities of water to stock wells in adjoining areas.
	Pennsylvanian			Madera limestone	450 to 2,000	Limestone, gray to red; upper part includes more clastic material than lower part.	Buried deeply; arkosic member yields small quantities of water to stock and domestic wells in adjoining areas.
				Sandia formation	0 to 415	Sandstone, shale, and limestone, brown, gray, red, and black; upper part generally clastic material, lower part generally limestone.	Buried deeply; yields small quantities of water to stock and domestic wells in adjoining areas.
Precambrian					18,000+	Metamorphic and igneous rocks.	Surficial weathered and fractured zones yield small quantities of water to springs and wells along mountain front for stock and domestic supplies.

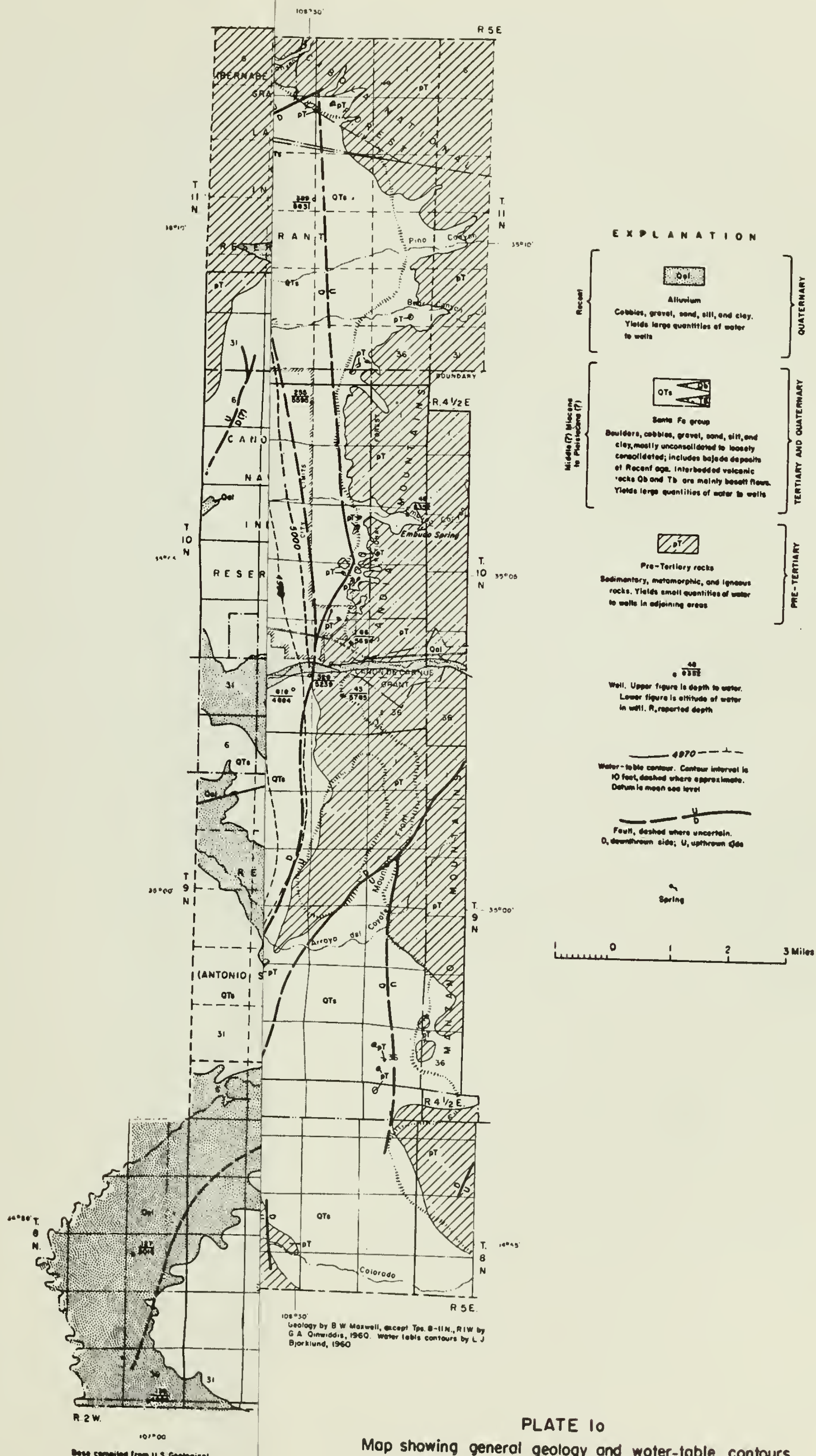


PLATE 1a

Map showing general geology and water-table contours in the southern half of the Albuquerque area, Bernalillo County, New Mexico.

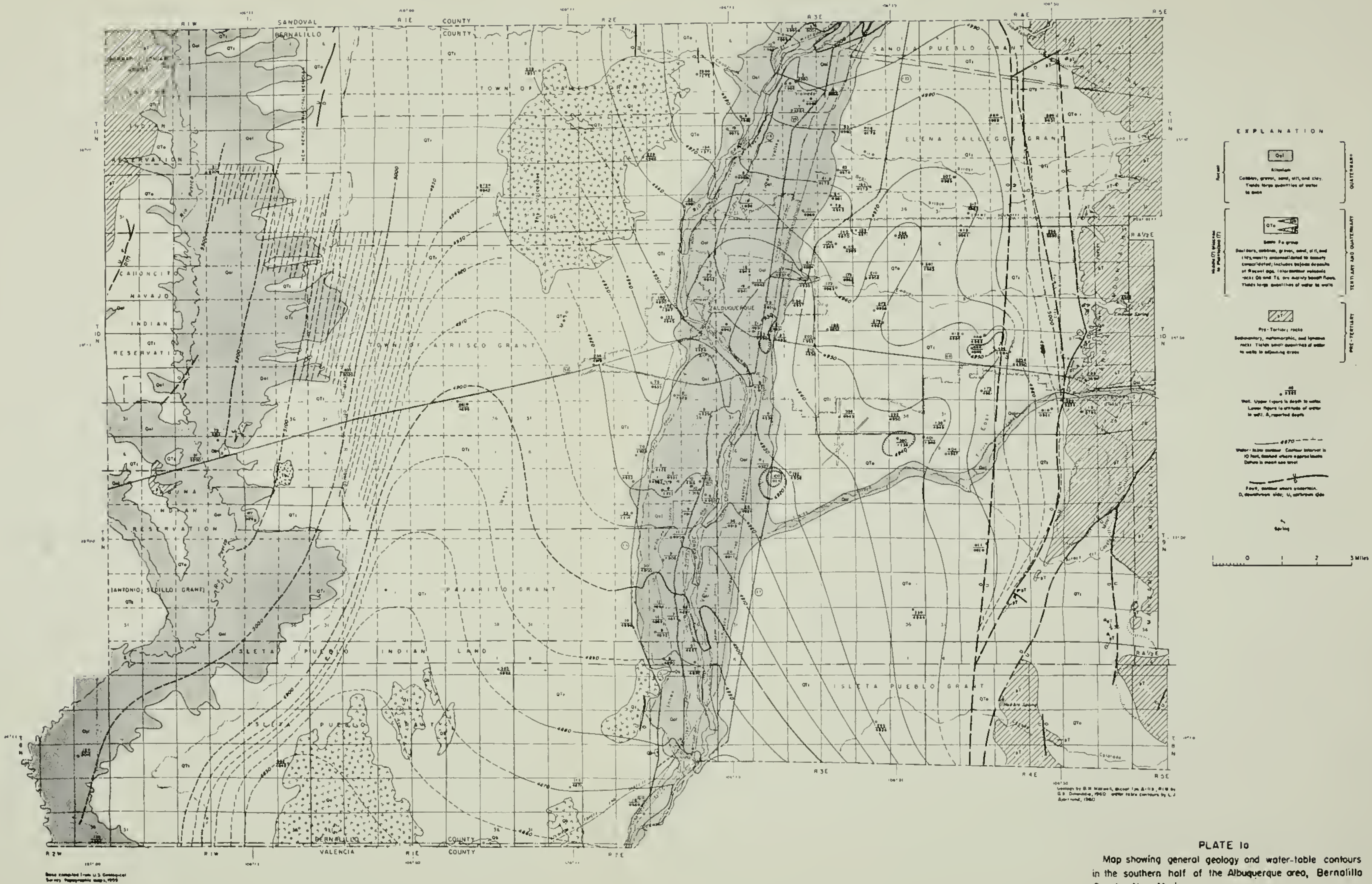
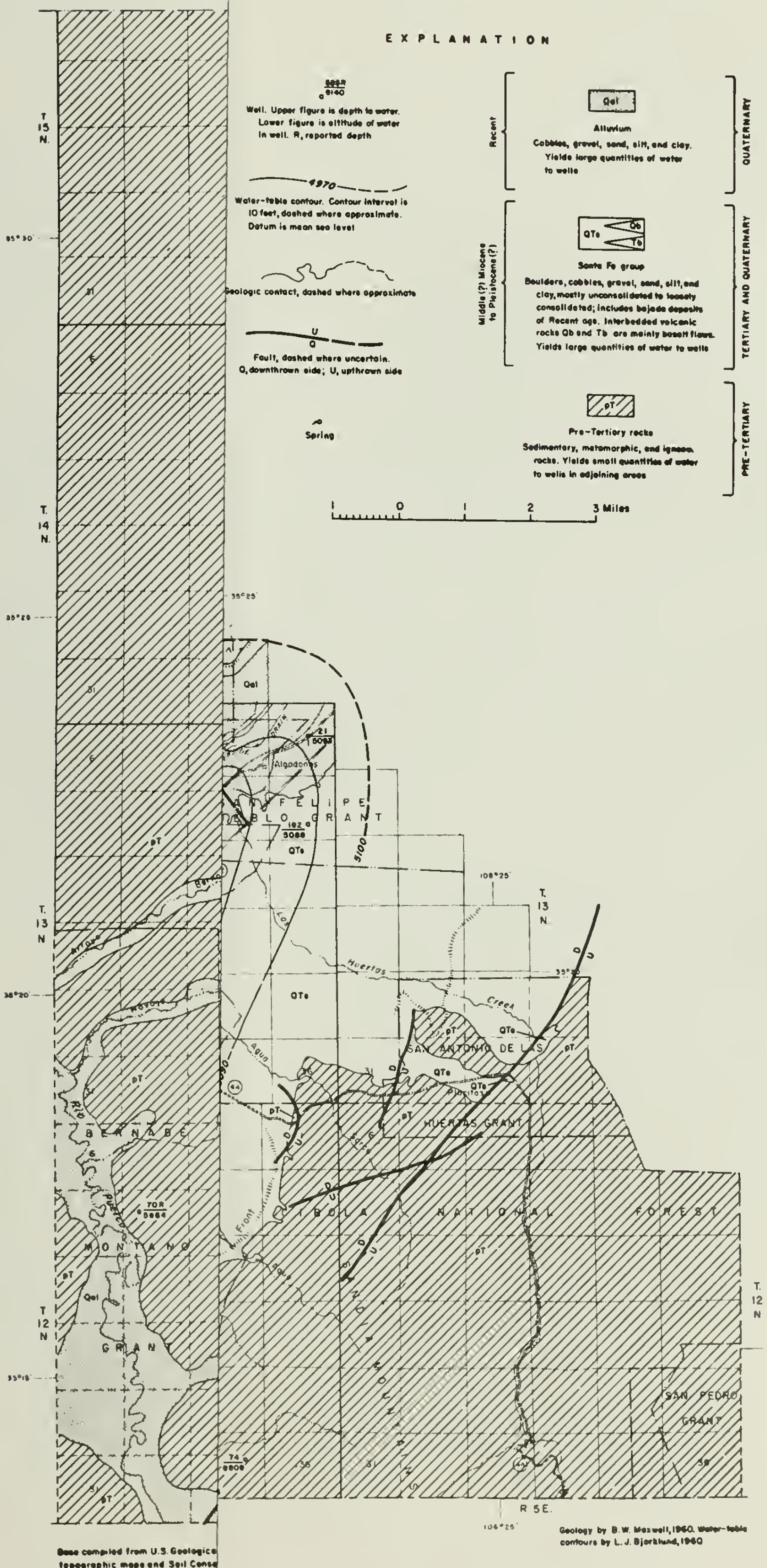


PLATE Ia

Map showing general geology and water-table contours in the southern half of the Albuquerque area, Bernalillo County, New Mexico.

PLATE Ib

Map showing general geology and water-table contours in the northern half of the Albuquerque area, Sandoval County, New Mexico.

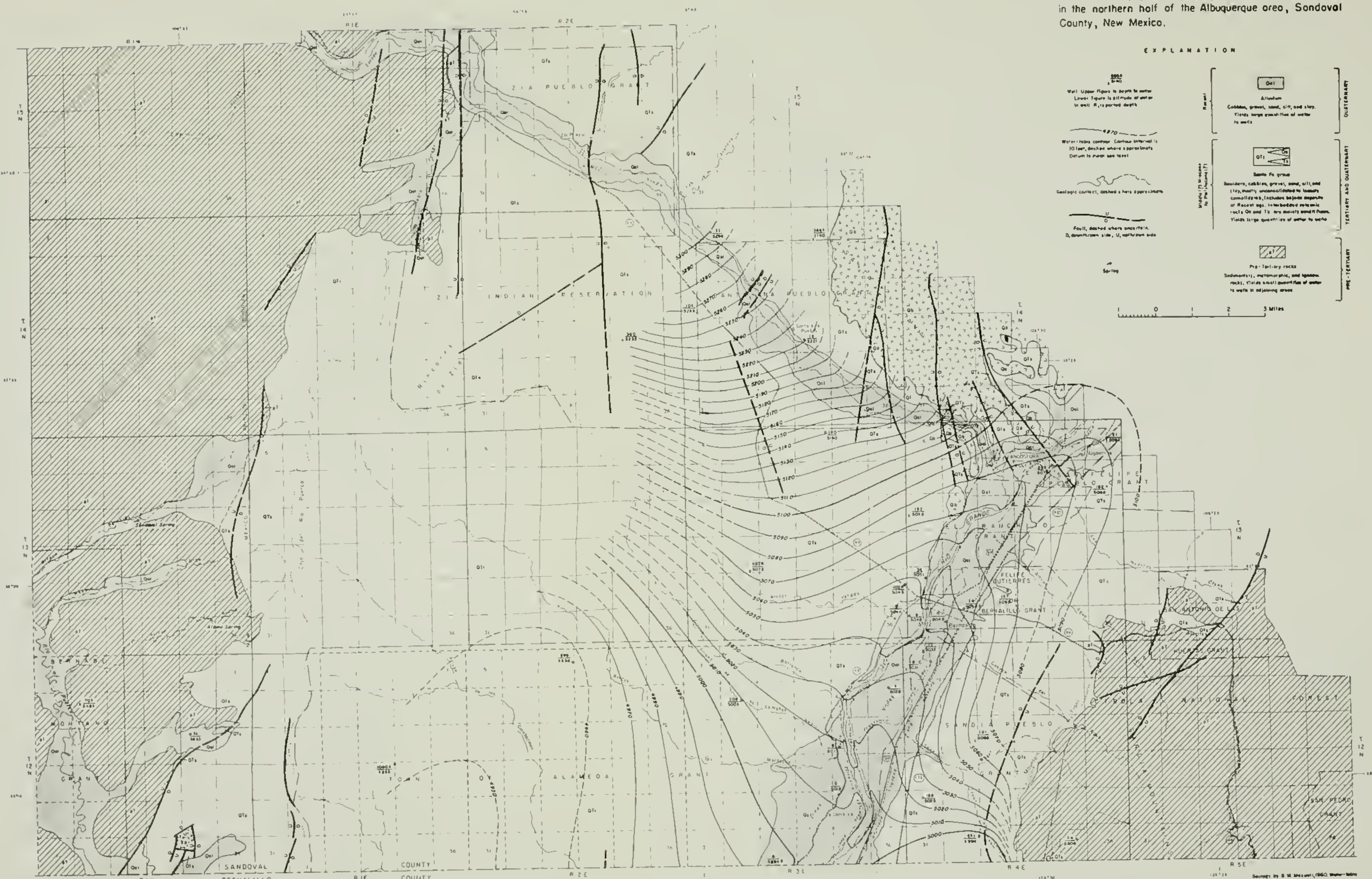


Base compiled from U.S. Geological Survey topographic maps and Soil Conservation Service planimetric maps, 1959

Geology by B.W. Maxwell, 1960. Water-table contours by L. J. Bjorklund, 1960

PLATE Ib

Map showing general geology and water-table contours in the northern half of the Albuquerque area, Sandoval County, New Mexico.



Base compiled from U.S. Geological Survey topographic maps and Soil Conservation Service planimetric maps, 1938

Geology by B. W. Maxwell, 1960. Water-table contours by L. J. Bjorklund, 1960 the region was uplifted and eroded. The sandstone and shale of the Galisteo formation were deposited in local basins north of the Albuquerque area during Eocene time (Stearns, 1953b, p. 467), and late in Eocene time volcanic activity provided the material that comprises the Espinaso volcanic sequence of rocks of Stearns (1943), north of the Sandia Mountains.

A cycle of erosion which began after uplift toward the close of the Eocene continued through Oligocene time and into the Miocene. Subsidence of the Rio Grande depression began in middle(?) Miocene time and has continued through Recent time; the subsidence was accompanied by uplift of the Sandia and Manzano Mountains. The highlands flanking the depression were subjected to vigorous erosion following the uplift, and the debris deposited in the depression formed the Santa Fe group and overlying bajada deposits.

Volcanic activity in Pliocene and Pleistocene time resulted in the formation of the Jemez caldera, the lava flows on Santa Ana Mesa, and the volcanoes west of Albuquerque and Isleta. The igneous sills in rocks of the Santa Fe group, recorded in the logs of wells 9.1.22.211, 9.1.22.211a, and 10.1.28.440 (table 5), probably are lava flows and indicate earlier volcanism that possibly occurred during late Miocene time.

Drainage during most of the Miocene probably was to closed basins (Wright, 1946, p. 390); by the close of the Miocene, drainage had become integrated and the ancestral Rio Grande developed as a through-flowing stream. By the end of Pliocene time the Rio Grande was established near its present course but several hundred feet higher. Rejuvenation of the stream in Pleistocene time resulted in downcutting to a depth about 120 feet below the present valley floor; several cut terraces were developed on the valley fill above the present valley floor. Aggradation which began after the downcutting and which has partly refilled the inner valley is continuing. Sand dunes along the Rio Grande, Jemez River, and Ceja del Rio Puerco were formed in Recent time.

Structure

The Rio Grande depression is a compound graben having a general north-south alinement, bordered on the east and west by upfaulted blocks (fig. 4). The upfaulted blocks to the east form the Sandia and Manzano Mountains and the block to the west forms the highlands west of the Rio Puerco and much of the Rio Puerco valley. The Jemez caldera and the Jemez uplift north of the Jemez River are in the western part of the graben.

At least two subparallel faults trend along the west base of the Sandia and Manzano Mountains. The bedrock thus rises from the floor of the graben to the crest of the mountains in steps (fig. 3). The fault zone bounding the west side of the graben may be similar to that on the east. The faults exposed appear to be *en echelon*; however, the structure cannot be determined with certainty because rocks of the Santa Fe group cover most of the faults. The bedrock floor of the graben probably is modified by many faults.

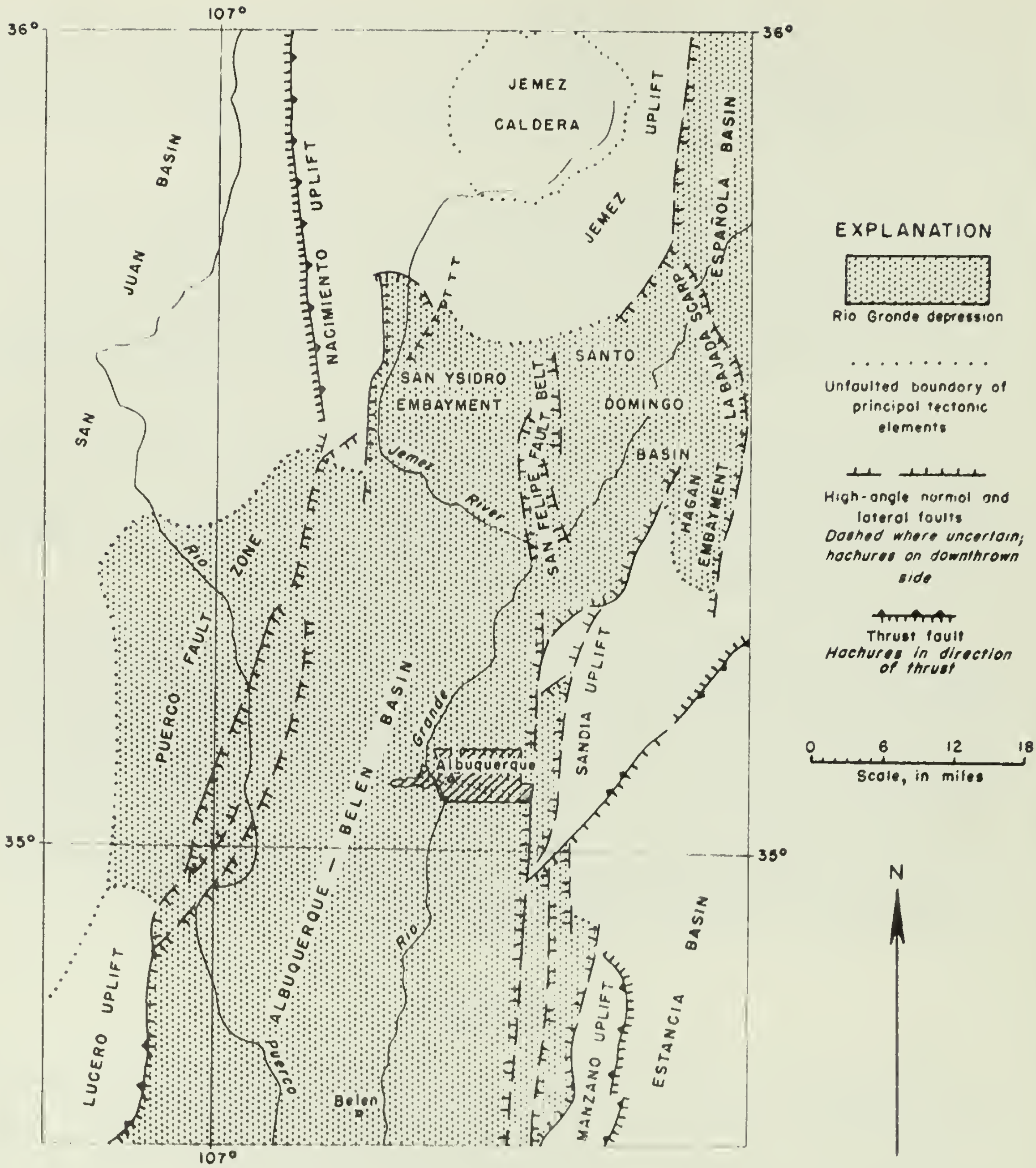


FIGURE 4. -- Tectonic diagram of part of the upper Rio Grande area, Bernalillo and Sandoval Counties, N. Mex. (adapted from Kelley, 1954).

Beds of the Santa Fe group dip toward the axis of the graben, but along the axis the beds are nearly horizontal. Some of the dip of the Santa Fe group is depositional; however, later faulting and movement along old faults in older beds has in places steepened the dip and caused faulting in the Santa Fe group.

Faulting in the Santa Fe group is particularly evident on Santa Ana Mesa, north of the Jemez River, where basalt flows preserve the fault scarps. The Santa Fe group is so easily eroded in most places that fault scarps usually are not preserved. Fault scarps preserved in the Santa Fe group and in the bajada deposits near Arroyo del Coyote (sec. 22, T. 9 N., R. 4 E.) and southwest of Hubble Spring (S8.4.9.314, table 4) indicate that movement along the faults has occurred in Recent time. A fault scarp in rocks of the Santa Fe group can be traced for about a mile north of Arroyo de las Calabacillas in the NE¼ sec. 3, T. 11 N., R. 2 E., and in the SE¼ sec. 34, T. 12 N., R. 2 E.; the fault does not displace a basalt flow south of the arroyo.

Some of the faults may be related to volcanic eruptions that occurred between the Rio Grande and the Rio Puerco. A normal fault exposed along the cliff 1½ miles northwest of Isleta in the SE¼ sec. 10 and the NE¼ sec. 15, T. 8 N., R. 2 E., appears to be dipping steeply toward the center of an extrusion of lava. Faults near Placitas are generally en echelon high-angle normal faults downthrown to the west (Stearns, 1953b, p. 478). In the Ceja del Rio Puerco the faults are generally high-angle normal faults downthrown on the east (Bryan and McCann, 1937, p. 824; Wright, 1946, p. 417).

Geologic Units and Their Water-Bearing Characteristics

Rocks of pre-Tertiary age underlie the Albuquerque area but crop out only in the Sandia and Manzano Mountains, in the Rio Puerco valley, and in the highlands west of the Zia Indian Reservation (pl. 1b). Rocks of Precambrian, Paleozoic, and Mesozoic age are exposed in the Sandia and Manzano Mountains. Rocks of Mesozoic age are also exposed west of the Zia Indian Reservation and in the Rio Puerco valley.

Precambrian

The granitic and metamorphic rocks of Precambrian age are more than 18,000 feet thick (Reiche, 1949, p. 1186) and are overlain by about 5,500 feet of sedimentary strata of Paleozoic and Mesozoic age (Read and others, 1945).

Precambrian rocks along the front of the Sandia and Manzano Mountains commonly yield water from cracks and weathered zones to wells and springs; the quantities are small but adequate for stock and domestic supplies. Well 10.4.35.231 (table 4), drilled in Precambrian granite, is reported to produce 1 barrel of water per day. Embudo Spring (S10.4.13.242, table 4) is reported to flow as much as 50 gpm from the granite in wet weather, but the flow is much less in dry weather. However, some holes drilled for water in rocks of Precambrian age have been dry.

Paleozoic and Mesozoic

Sedimentary rocks of Paleozoic and Mesozoic age are about 5,500 feet thick. The lower part of this sequence consists mainly of marine limestone, shale, and sandstone. The upper part consists mainly of continental and marine shale and of sandstone with some gypsum, coal, and conglomerate. Rocks of Mesozoic age crop out in the Rio Puerco valley and the highlands west of Zia Pueblo. Rocks of Paleozoic and Mesozoic age crop out in the Sandia and Manzano Mountains.

Rocks of Paleozoic and Mesozoic age are known to yield water to only one well (12.1W.8.132, table 4) in the Albuquerque area, but they are the source of water for many stock and domestic wells in adjoining areas. Most of the wells in adjoining areas produce only small amounts of water, but some wells that tap beds of sandstone produce several tens of gallons per minute. The quality of water in rocks of pre-Tertiary age generally is suitable for stock and domestic use, but a few stock wells have been abandoned because the water was unsuitable.

Tertiary and Quaternary

Rocks of Tertiary and Quaternary age crop out over most of the project area except in the Sandia and Manzano Mountains, in the highlands west of Zia Pueblo, and in part of the Rio Puerco valley. They unconformably overlie rocks of pre-Tertiary age and are generally composed of unconsolidated to loosely consolidated gravel, sand, and silt and a few beds of basalt and tuff; in places the sequence is more than 6,000 feet thick. All water wells of large capacity are completed in rocks of Tertiary and Quaternary age.

Galisteo Formation

The Galisteo formation of Eocene and Oligocene(?) age crops out in two small areas near Placitas and probably is present deep in the subsurface farther south near Albuquerque. Stearns (1953b, p. 476) suggested that the lower 2,875 feet of strata in the Norrins oil-test well (11.4.19.144, table 5) may be a part of the Galisteo formation but that more probably they are equivalent to his Espinaso volcanic rocks and the lower part of the Santa Fe group. The Galisteo formation consists of beds of sandstone, sand, clay, and shale, generally variegated, and minor amounts of conglomerate, tuff, and limestone. The thickness ranges from 900 to 4,000 feet north of the Albuquerque area; no wells are known to tap the formation in the Albuquerque area.

Espinaso Volcanic Rocks of Stearns (1943)

The Espinaso volcanic rocks of Stearns (1943) of late Eocene age crop out north of the Albuquerque area and may extend southward in the subsurface to the vicinity of Albuquerque (Stearns, 1953b, p. 476). The volcanic rocks consist of water-laid tuff, conglomerate, and breccia; they probably become finer grained in the Albuquerque area if they are present in the subsurface (Stearns, 1953b, p. 476). The volcanic rocks are 1,400 feet thick 8 miles northeast of Placitas. No wells are known to tap the formation in the Albuquerque area.

Santa Fe Group

The Santa Fe group, of middle(?) Miocene to Pleistocene(?) age, of which the latest available description is that of Spiegel and Baldwin (1958), underlies the surficial deposits in the Rio Grande valley and crops out on the east and west mesas. It is difficult to correlate recognized units of the Santa Fe group in other areas with units of the Santa Fe group in the Albuquerque area because the beds are lenticular and are faulted and folded, and the exposures are generally discontinuous.

Almost all the Santa Fe group exposed in the Albuquerque area is equivalent to the Ancha formation and the upper part of the Tesuque formation (fig. 5), as defined and described by Spiegel and Baldwin (1958). Before the Santa Fe was raised from formation to group status, Bryan and McCann (1937) had divided it into three members -- the Lower Gray, the Middle Red, and the Upper Buff. The Ancha formation is equivalent to the Upper Buff member, whereas the Tesuque formation is equivalent to the Lower Gray and Middle Red members. The lower part of the Tesuque formation (Lower Gray member of Bryan and McCann) crops out in the Rio Puerco valley near the Bernalillo-Sandoval County line.

The Santa Fe group consists of beds of unconsolidated to loosely consolidated sediments and interbedded volcanic rocks. The sediments range from boulders to clay and from well-sorted stream deposits to unsorted mudflows. Extrusive volcanic rocks of Tertiary and Quaternary age are interbedded with the sediments. The extrusive rocks are mainly basaltic and generally overlie pyroclastic material.

Materials of the Santa Fe group in the Albuquerque area were derived by erosion of the highlands east and west of the Rio Grande depression and by volcanic activity and erosion of the highlands farther north. The Santa Fe group on the east side of the Rio Grande depression, adjacent to the Sandia and Manzano Mountains, consists mostly of debris derived from rocks of Precambrian age in the mountains. The debris, which is composed mainly of feldspar and quartz fragments but contains a few fragments of metamorphic and sedimentary rocks, ranges in size from very large boulders to clay. The material is coarse but unsorted near the mountains and becomes finer grained and better sorted west of the mountains. The Santa Fe group on the west side of the Rio Grande depression consists mostly of debris of sedimentary rocks of Mesozoic and Paleozoic age from the highlands to the west. It consists chiefly of fine-grained sand, silt, and clay.

The Santa Fe group in the central part of the depression is a mixture of material from the east, west, and north. Individual beds may contain

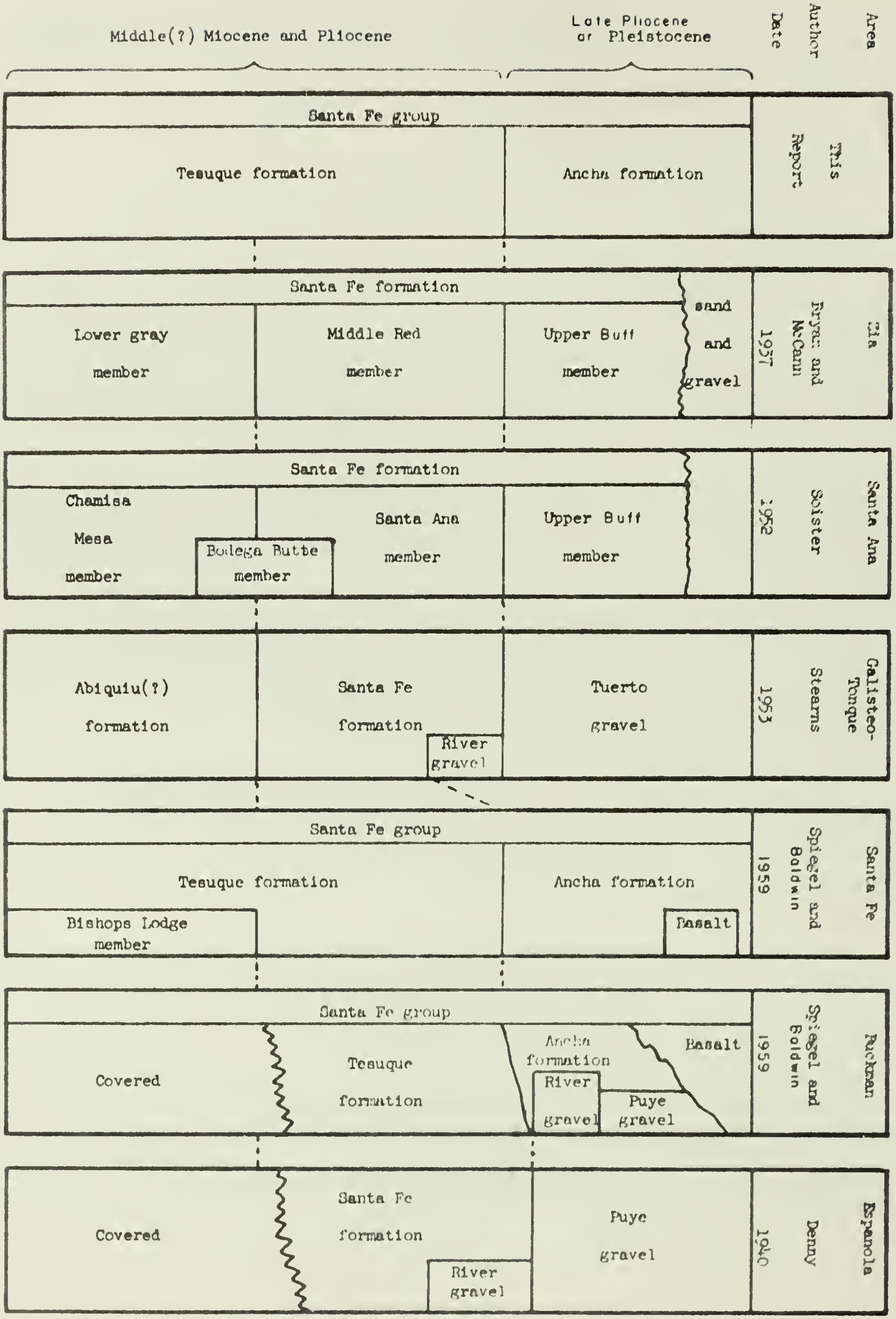


FIGURE 5. -- Nomenclature of the Santa Fe group in north-central New Mexico (adapted from Spiegel and others, 1958).

material from all the sources or may contain material from only one of them. Some of the beds consist almost entirely of gravel derived from resistant igneous and metamorphic rocks north of the Albuquerque area. Some of the beds consist of water-laid pumice interbedded with quartz sand. Several pumice beds are exposed (sec. 15, T. 11 N., R. 3 E.) in the bluffs along the east side of the valley floor; the fragments of pumice range in size from cobbles to sand.

An oil-test well (10.1.28.440, table 5) on the west mesa, 10 miles west of Albuquerque, penetrated 6,100 feet of the Santa Fe group before entering rocks of Cretaceous(?) age. An oil-test well (6.1.18), 9 miles south of the project area, penetrated about 9,000 feet of the Santa Fe. The maximum thickness of the group is unknown but exceeds 9,000 feet.

The average permeability of the Santa Fe group generally is high except in the Rio Puerco valley along the west side of the graben and in the lower part of the group along the base of the Sandia and Manzano Mountains. Near the mountain front and in the Rio Puerco valley the permeability of the group has been decreased by cementation along several fault zones; this cementation probably was caused by precipitation of dissolved mineral matter from water rising along faults. The permeability of the group has been decreased also by the formation of extensive near-surface beds of caliche which underlie parts of the Llano de Albuquerque and the east mesa; evidence of similar beds at depth has been found in drillers' logs (table 5). An area where low permeability is due to the presence of fine-grained sediments extends southward from the Bernalillo-Sandoval County line on the east side of the Rio Puerco and is about 4 or 5 miles wide. Another area of low permeability caused by fine-grained sediments just south of Tijeras Arroyo on the east mesa is indicated at well 9.4.20.221 (table 2).

Wells properly constructed in the Santa Fe group will yield several hundred gallons of water per minute except in the areas of low permeability. The wells of large capacity usually are screened and gravel packed to reduce the amount of sand pumped.

Water in the Santa Fe group generally is of good quality and is suitable for most uses. However, the concentration of silica in the water in some areas is large and the water must be treated for use in high-pressure boilers. Most of the public-supply and industrial wells in the area tap the Santa Fe group.

Bajada Deposits

The bajada deposits of Recent age are a series of coalescing alluvial fans deposited unconformably on the Santa Fe group. They extend westward from the base of the Sandia and Manzano Mountains to the bluffs along the east side of the Rio Grande valley. The bajada deposits are not differentiated from the Santa Fe group on the geologic map because the fan material near the mountains is indistinguishable from sediments of the Santa Fe group; however, in the bluffs that bound the inner valley of the Rio Grande the contact is conspicuous, rocks of the Santa Fe group being red to gray and the overlying bajada deposits being buff colored and somewhat finer grained.

The sediments composing the bajada deposits range from poorly sorted mudflow material to well-sorted stream gravel. The beds are discontinuous and consist of channel fill and lenticular interchannel deposits. The bajada deposits are mostly arkosic and were derived from the granitic rocks in the mountains to the east; however, some of the material consists of fragments of metamorphic and sedimentary rocks. The bajada deposits range in thickness from 0 to about 200 feet and are thickest toward the east edge. The deposits generally are above the water table and are not an aquifer; however, along the mountain front they may be saturated and may yield small amounts of water. Much of the floodflow in the arroyos infiltrates into the deposits and percolates downward into the Santa Fe group.

Alluvium

Alluvium of Recent age underlies the flood plain of the Rio Grande and its tributaries. The alluvium is similar in appearance and composition to sediments of the underlying Santa Fe group and was derived from them in much of the area. Faults and folds are not apparent in the alluvium and the beds are more nearly horizontal than those of the Santa Fe.

The contact of the alluvium with the underlying Santa Fe group can be distinguished in well cuttings only with difficulty, but the contact probably is at a change in lithology and consolidation which generally is present between 80 and 120 feet below the land surface; this thickness of alluvium is considerably less than the 200 feet estimated by Bryan (1938, p. 218). The alluvium probably is thickest where fans from tributary valleys extend into the main valley and thinnest in the tributary valleys. The alluvium in the larger valleys only is shown on the geologic map (pls. 1a and 1b).

Most of the irrigation and domestic wells along the Rio Grande tap the alluvium; some wells are reported to yield as much as 3,000 gpm. The alluvium in the valleys tributary to the Rio Grande is not saturated except in some arroyos tributary to the Rio Puerco and in arroyos along the mountain front; where this alluvium is underlain by relatively impermeable rocks, wells tapping it have small sustained yields.

The quality of water in the alluvium generally improves with depth and in the lower part is similar to that of water in the underlying Santa Fe group.

GROUND WATER

Principles

The principles governing the occurrence and movement of ground water have been discussed by Meinzer (1923a, b); the reader is referred to that report for a detailed discussion of the subject.

The zone in which the rocks are saturated with water under hydrostatic pressure is called the "zone of saturation." A moist zone just above the zone of saturation is called the "capillary fringe." It ranges in thickness from a fraction of an inch in coarse sand or gravel to several feet in silt or clay. The upper surface of the zone of saturation in permeable rock or soil is called the "water table" and the water is said to be under "water-table conditions." Where the upper surface of the zone of saturation is formed by impermeable rock, the water table is absent and artesian conditions are said to exist (Meinzer, 1923b, p. 32). For instance, if a well is drilled and the hole remains empty until it passes through impermeable rock and enters a saturated permeable bed below, and if water then flows into the well and rises some distance above the level at which it was struck, then the water is said to be under artesian conditions.

The imaginary surface defined by the height to which artesian water will rise in wells is known as the "piezometric surface." Under artesian conditions, water will flow from the well if the piezometric surface is above the top of the well. In the Albuquerque area the principal aquifer, or water-bearing unit, is the permeable valley fill and ground water for the most part is under water-table conditions.

Ground water in gravel, sand, silt, and clay occupies the space between particles. In igneous rocks and in consolidated sedimentary rocks, ground water is found also in fractures or in solution cavities. The spaces generally are interconnected, allowing water to move through the water-bearing materials under the force of gravity. The interconnected spaces in graded material such as relatively uniform gravel or sand are larger and store and conduct more water than do like spaces in mixed gravel, sand, and silt, because the finer particles partly fill the spaces between the coarser particles.

The percentage, by volume, of the open space in a material is referred to as "porosity." The porosity of valley-fill materials, such as are found in the Rio Grande valley, ranges from a few percent in poorly-sorted material to 50 percent or more in beds of clay. The porosity of natural gravel is between 20 and 30 percent. Not all the water stored in the spaces can be drained by gravity, however, as some of it is retained in the materials by adhesion. In fine-grained material such as clay, all or nearly all the water is so retained when the material is subjected to gravity drainage.

The "specific yield" of an aquifer is defined as the ratio of the 1) volume of water that a saturated aquifer ultimately will yield by gravity to 2) the volume of the aquifer. The volume of the water retained, expressed as a ratio of the total volume of the material, is called the "specific retention of the material." The specific yield and the specific retention together are equal to the porosity. Thus, if 100 cubic feet of a saturated formation will yield 8 cubic feet and retain 13 cubic feet of water, when drained by gravity, the specific yield is 8 percent, the specific retention is 13 percent, and the porosity is 21 percent.

The "coefficient of storage" of an aquifer is defined as the volume of water released from or taken into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface (Ferris and Knowles, 1955, p. 5), and it is an index of the amount of water available from storage in the aquifer. The coefficient of storage is small under artesian conditions, generally 0.001 to 0.00001, and under declining pressure it represents water released by compaction of fine-grained materials, as the beds take more of the load of the overlying material, and by expansion of the water itself. The coefficient of storage under water-table conditions includes this small amount plus the generally much larger amount of water that drains by gravity out of the uppermost material as the water table declines. Although no tests have been made to determine the coefficient of storage of the valley fill in the Albuquerque area, the estimated average value is 0.2.

The capacity of a water-bearing material to transmit water under a head differential depends upon the thickness and permeability of the material. The permeability varies with the size, shape, and number of void spaces and their degree of interconnection. The coefficient of permeability used in this report is called the "field coefficient of permeability" and is defined as the number of gallons of water per day that percolates, under prevailing conditions, through each mile of water-bearing bed (measured at right angles to the direction of flow) for each foot of thickness of the bed for each foot per mile of hydraulic gradient (Wenzel, 1942, p. 7-11). The "coefficient of transmissibility" may be expressed as the number of gallons per day, under prevailing conditions, transmitted through each mile strip of the aquifer under a hydraulic gradient of 1 foot to the mile; hence, it is the average field coefficient of permeability, as defined above, multiplied by the saturated thickness of the aquifer in feet.

The apparent coefficient of transmissibility of the water-bearing materials in the Santa Fe group was determined at 23 wells by measuring the drawdown and recovery of water levels during and after pumping at measured rates and using the Theis recovery formula as described by Ferris and Knowles (1955, p. 31-32). The determined coefficient of transmissibility ranged from 50,000 to 600,000 gpd per foot at 22 of the wells and was 7,500 at the other well. The average transmissibility at the 23 wells was 230,000 gpd per foot. Coefficients determined at specific wells are listed in tables 1, 2, and 3 under "Remarks."

The average apparent coefficient of permeability at a well was determined by dividing the coefficient of transmissibility by the penetrated thickness of the saturated materials. At the 23 wells tested this value ranged from 12 to 840 and averaged 340 gpd per square foot. It should be remembered that the permeability of most aquifers is not uniform throughout the saturated section and that the actual permeability of the Santa Fe group probably ranges from near zero in some local beds of clay to several thousand gallons per day per square foot in local beds of well-graded gravel. However, the average permeability is useful because it indicates the general conditions.

High coefficients of transmissibility, mostly between 100,000 and 600,000 gpd per foot, were determined at wells on the east mesa in Tps. 10 and 11 N. (table 2). Wells in this area tap gravel and sand in the Santa

Fe group. Coefficients between 50,000 and 100,000 gpd per foot were determined at wells in the inner Rio Grande valley on both sides of the river in and near Albuquerque. Wells in this area tap sand and silt in the Santa Fe group. A relatively low coefficient of transmissibility, 7,500 gpd per foot, was determined at well 9.4.20.221 where most of the saturated section consisted of sand, silt, and clay.

The coefficients of permeability formed the same pattern as described for the coefficients of transmissibility in the foregoing paragraph. This range was 130 and 840 gpd per square foot on the east mesa in Tps. 10 and 11 N., 54 to 78 in the inner valley in and near Albuquerque, and 13 at well 9.4.20.221 (table 2). This similarity of pattern is due partly to the relatively narrow range in saturated thickness, 496 to 871 feet at the 23 wells tested.

Relatively low transmissibilities and permeabilities are indicated in the western part of the west mesa, the Rio Puerco valley, and the Jemez River valley, although aquifer tests were not made in these areas. Much of the material composing the valley fill in these areas was derived from Mesozoic rocks and contains more silt and clay than the valley fill along the eastern side of the area. Furthermore, the water-table gradient generally is steeper in the western part of the area (pls. 1a and 1b), and this suggests lower permeability and transmissibility.

Ground water moves in response to the force of gravity in the direction of least resistance. The quantity of water flowing through water-bearing materials is directly proportional to the permeability of the water-bearing materials (P), the slope of the water table or piezometric surface (I), and the area of the cross section through which it flows (A). This quantity (Q) is expressed in accordance with Darcy's law: $Q = PIA$. The average velocity (V) of water moving through water-bearing materials is directly proportional to the slope of the water table or piezometric surface and to the permeability of the materials, but it is inversely proportional to the porosity (p) of the material. It is expressed by the formula $V = \frac{PI}{p}$. The determination of actual rate of movement of ground water is of importance mostly in problems of contamination or where circulation involving the temperature of the water is a problem. Under natural conditions in the Albuquerque area, ground water moves through the valley fill at average rates of less than 100 feet per year, although the rate of movement probably is much greater or much less in particular zones within the aquifer where the permeability is exceptionally high or exceptionally low. Near pumped wells the rate of movement toward the well is considerably increased.

Occurrence

The valley fill is the principal aquifer in the Albuquerque area and is composed mostly of unconsolidated and loosely consolidated gravel, sand, silt, and clay. The valley fill includes two geologic units -- the Santa Fe group (including the bajada deposits where present) and the alluvium. The alluvium and the Santa Fe group are interconnected hydraulically, and water moves from one formation into the other in accordance with the local hydraulic gradient. The alluvium and the Santa Fe group collectively make up a single aquifer which is referred to as "the ground-water reservoir" or "the underground reservoir" in this report.

The ground water in the valley fill generally is under water-table conditions, but locally artesian conditions may exist owing to a confinement of saturated gravel or sand beds between beds of silt or clay. The saturated zone in the valley fill has definite natural bounds at each side, at the bottom, and at the top. On the east side the ground-water reservoir is bounded by the hard, relatively impermeable rocks of the upfaulted blocks that form the Sandia and Manzano Mountains. On the west the reservoir is bounded by similar, but less spectacular, upfaulted blocks near the Rio Puerco. The bottom of the reservoir is formed by beds of consolidated rock, probably of Mesozoic age, which were downfaulted to form the depression in which the valley fill was deposited. The water table (fig. 3 and pls. 1a and 1b) marks the top of the ground-water reservoir in the valley fill. The ends of the reservoir are open, for the valley fill in the Albuquerque area is only a segment of the ground-water reservoir that extends the length of the Rio Grande.

Electric and radioactivity logs of an oil-test hole (10.1.28.440, table 5) drilled to a depth of 6,652 feet about 9 miles west of the Rio Grande indicate that the bottom of the fill at that point is about 6,100 feet below the land surface. The depth to water is about 900 feet; consequently, the saturated part of the valley fill at this site is about 5,200 feet thick. The valley fill is believed to be thicker than 6,100 feet at other places, especially nearer the middle of the valley.

In nearly all the area underlain by valley fill there is ground water at depth in the fill, and over much of the area large supplies of water can be developed from this ground-water reservoir. In places where the fill is thin, such as near the Sandia Mountains, and in places where a thick section of silt or clay has been deposited, the yields of wells may be expected to be moderate to small.

The amount of ground water contained in geologic formations in the project area other than the valley fill is relatively small. Weathered and fractured zones near the surface of the rocks of Precambrian age near the west base of the Sandia and Manzano Mountains yield relatively small quantities of water to a few springs and wells. Small quantities of water are found also in rocks of Paleozoic and Mesozoic age along the Sandia-Manzano mountain front and in rocks of Mesozoic age in the general vicinity of the Rio Puerco.

Development and Utilization of Ground Water

Ground water is pumped from wells for public, irrigation, industrial, domestic, and stock uses. In past years of surface-water scarcity, irrigation probably has made the greatest use of water from wells; but, owing to the growth of Albuquerque, the use of water from wells for public supply probably will represent the greatest demand in future years, regardless of the supply of surface water that may be available.

Construction of Wells

Wells in the Albuquerque area are mostly of two types -- drilled and driven. The drilled wells produce the largest amounts of water. For the purpose of this report, wells in the project area are divided arbitrarily into two groups: large-discharge wells that yield more than 200 gpm and small-discharge wells that yield less than 200 gpm.

Wells designed for large yields are drilled mostly 12 to 30 inches in diameter by either the standard-rotary or the reverse-rotary method. Steel casing, 8 to 18 inches in diameter and perforated at places opposite the water-bearing zones, is set in the well, and the annular space between the casing and the outside of the drilled hole commonly is filled with gravel of a selected size range, such range depending on the size range of the material composing the aquifer. Usually gravel averaging about a quarter of an inch in diameter, commonly called "pea gravel," is used locally. Wells commonly are "improved" or "developed" by swabbing, surging, and pumping after the casing has been set and the gravel pack placed. Development usually results in an increased yield for a given drawdown or pumping level and in a decrease in the amount of sand and silt pumped with the water. Detailed information regarding methods of drilling, constructing, and developing wells is given by Bennison (1947), and the U. S. Departments of the Army and the Air Force (1957).

Drilled wells designed for discharge of less than 200 gpm usually are drilled 6 or 8 inches in diameter, are cased with 4- or 6-inch steel pipe, and penetrate 10 to 40 feet of saturated water-bearing materials. Most of the small-discharge wells on the inner valley floor, where the water table is near the surface, are constructed by driving well points into the ground; most of these driven wells are less than 50 feet deep.

Wells of large yield that tap the Santa Fe group usually are drilled at least 200 feet into water-bearing material. Large-yield wells that tap the alluvium in the inner valley are drilled 50 to about 120 feet into water-bearing material, according to the thickness of the alluvium at the site.

Some difficulty has been experienced with the pumping of sand from wells tapping the Santa Fe group; the problem is more common in wells on the valley floor and westward than in wells on the east mesa. Some wells in the downtown area of Albuquerque are yielding sand after several years of continual use, and it has been necessary to install sand traps in the discharge lines of these wells.

Voids are developed by the removal of sand from the water-bearing beds near a well as the well is pumped. These voids are filled at least partially by the settling of the gravel pack; as settling occurs the pack should be renewed at the top of the well. When sand is pumped and the gravel pack fails to settle and fill the voids thus created, the voids may become large enough to cause collapse of the well. The amount of gravel necessary to fill voids created by pumping sand during development and use of a well may range from a negligible amount to several hundred cubic yards.

Drawdown and Specific Capacity of Pumped Wells

When water is pumped from a well the water level in the well is lowered; the amount of lowering is called the "drawdown" of the well. The drawdown varies with the rate of pumping. It is rapid at first and then gradually slows until the pumping level is virtually stationary. The rate of pumping per foot of drawdown is called the "specific capacity" of the well and usually is expressed in gallons per minute (gpm) per foot. The specific capacity decreases with time, the decrease being smallest when the drawdown is only a small fraction of the available head. The specific capacity varies also with differences in construction and development of wells. However, a comparison of specific capacities is useful in estimating the relative efficiency of wells and the permeability of aquifers.

The specific capacities of the large-discharge wells in the Albuquerque area range from about 10 to as much as 150 gpm per foot of drawdown, although the specific capacities of most wells range from 20 to 100 gpm per foot. The average specific capacity of 66 selected wells whose discharge and drawdown were measured or reported was 44 gpm per foot. The average specific capacity of large-discharge wells in the alluvium is roughly similar to that of large-discharge wells in the Santa Fe group, although the penetration of water-bearing materials in the Santa Fe generally is greater; the alluvium generally is more permeable but is much thinner than the Santa Fe group.

Municipally Owned Public Supplies

The city of Albuquerque and the town of Bernalillo have municipally owned public water-supply systems. Wells that supply water to these systems are listed in table 1 and are shown on plates 2a and 2b.

Albuquerque

The city of Albuquerque system is supplied with water from 77 wells ranging in depth from 65 to 1,284 feet. Wells more than 120 feet deep generally tap water in the Santa Fe group and the wells less than 100 feet deep probably tap the alluvium exclusively. Wells in the inner valley that are between 100 and 200 feet in depth may derive water from both the Santa Fe group and the alluvium.

Most of the city wells are grouped into well fields. Each field has a central collection point where water is cleaned, chlorinated, and pumped into the city water-distribution system. The well field of a particular well is indicated in table 1 under "Remarks." The location of well fields and the number of wells in each field as of July 1960 are shown in the following table.

Location and Number of Wells in the Albuquerque Municipal Well Fields

Well field	Location	Number of wells
Main Plant	Inner valley near northeast part of downtown Albuquerque in secs. 8, 9, 17, and 20, T. 10 N., R. 3 E.	22
Atrisco	Inner valley in Atrisco, west of the Rio Grande, in secs. 23, 24, and 25, T. 10 N., R. 2 E.	14
Duranes	Inner valley northwest of downtown Albuquerque and east of the Rio Grande in secs. 1, 12, and 13, T. 10 N., R. 2 E., and sec. 7, T. 10 N., R. 3 E.	7
San Jose	Inner valley south of downtown Albuquerque in secs. 29 and 32, T. 10 N., R. 3 E.	7
Griegos	Inner valley north of downtown Albuquerque in sec. 36, T. 11 N., R. 2 E., and secs. 31 and 32, T. 11 N., R. 3 E.	5
Candelaria	Inner valley north of downtown Albuquerque in secs. 4 and 5, T. 10 N., R. 3 E.	4
Love	East mesa in secs. 16 and 20, T. 10 N., R. 4 E.	5
Thomas	East mesa in sec. 5, T. 10 N., R. 4 E., and secs. 31 and 32, T. 11 N., R. 4 E.	4
Leyendecker	East mesa in sec. 1, T. 10 N., R. 3 E., and sec. 36, T. 11 N., R. 3 E.	4
Bel Aire	East mesa in sec. 11, T. 10 N., R. 3 E.	3
Burton Reservoir	East mesa in sec. 27, T. 10 N., R. 3 E.	1
West Mesa	West mesa in sec. 21, T. 10 N., R. 2 E.	1

The average pumping rate in the Albuquerque system increased from about 2 mgd (million gallons per day) in 1930 to about 33 mgd in 1959 (fig. 6). The heaviest daily average rates of pumping usually are in June, July, or August, according to the amount of rainfall; pumping during these months is about twice the average for other months. Minimum daily average pumping rates occur during December, January, and February, which are the months of lowest pumping rates. The reported maximum daily pumpage in 1959 was 72,819,000 gallons on July 10; this is slightly more than double the average daily pumpage for the year.

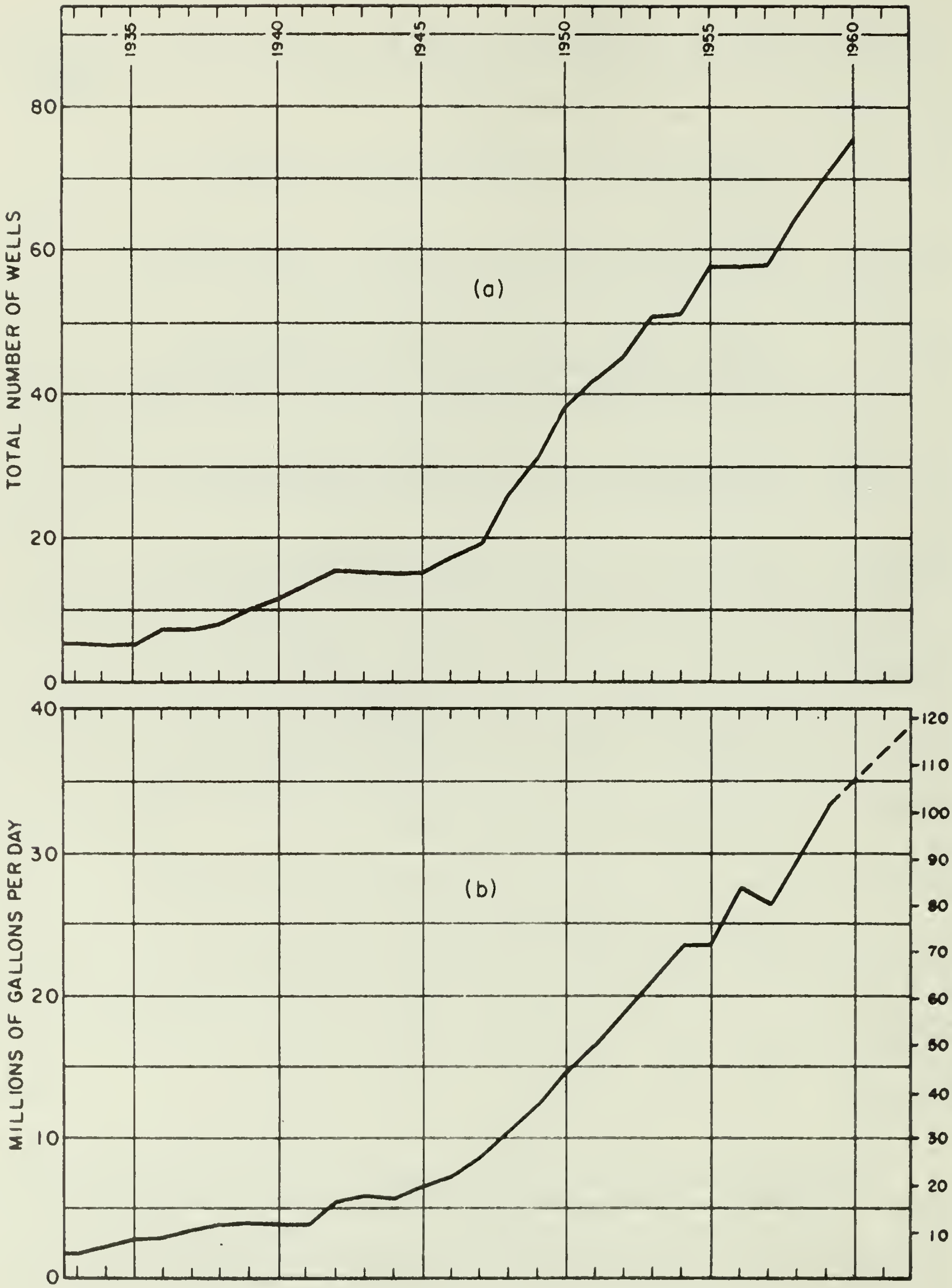


FIGURE 6. (a) Cumulative number of municipally owned public-supply wells, and (b) average daily pumpage from municipal public-supply wells, Albuquerque, N. Mex., 1930-60.

If the use of water continues to increase at the rate anticipated, the city in 1965 will be pumping about 45 mgd and in 1970 will be pumping about 55 mgd -- the equivalent of 170 acre-feet per day, or a steady flow of about 85 cfs (cubic feet per second).

Bernalillo

The town of Bernalillo (1960 population 2,574) is supplied with water from two wells (table 1) within the town limits. The wells are 500 and 528 feet deep and tap the Santa Fe group. The water is chlorinated at the wells and pumped directly into the distribution system; water is stored and operating pressure is maintained by means of an elevated steel tank. Pumpage data were not available but the average daily pumpage is believed to be about 150,000 gallons.

Nonmunicipal Water Supplies

In addition to municipal water-supply systems, some business establishments, some urban developments, and some public and private institutions have individual water systems. Wells in these individual systems are tabulated below, and the reader is referred to table 2 for additional information about particular wells.

Nonmunicipal Water Supplies in the Albuquerque Area

	Number of wells pumped	
	Less than 100 gpm	More than 100 gpm
Government installations		
Sandia Base		8
Manzano Base		1
Kirtland Air Force Base		2
Schools		
University of New Mexico		4
College of St. Joseph		1
Public and parochial schools (Elementary, secondary, and orphanages)	18	
Albuquerque Board of Education (Supply for administration building and several schools)		1
Hotels		
Hilton		1
El Fidel		1
Alvarado (supplied by A.T. and S.F. Co. wells)		2
Franciscan		1
Hospitals		
Veterans Administration Hospital		1
St. Joseph Sanatarium and Hospital		1
Urban developments		
Valley Utilities, Inc.		1

Nonmunicipal Water Supplies in the Albuquerque Area (continued)

	Number of wells pumped	
	Less than 100 gpm	More than 100 gpm
Others		
Bernalillo County Court House		1
United Pueblo Indian Agency (Indian School)		1
Totals	18	27

An average of about 5,000,000 gpd, or 5,600 acre-feet a year, is pumped from privately and institutionally owned wells. About 63 percent of this amount is pumped from 11 wells to supply three large Federal installations and about 20 percent is pumped from 4 wells, owned by the University of New Mexico, to supply buildings, grounds, and a golf course. The remaining 17 percent is pumped from 30 wells serving schools, hospitals, hotels, a suburban development, and a public building. Most of these water systems have emergency connections with the Albuquerque water-supply system in case of breakdown or fire, and most of the institutions or establishments are served by the Albuquerque sewer system.

Industrial Use of Water

Many industries and commercial institutions in Albuquerque obtain their water supply from privately owned wells. These are primarily industrial wells and the use of the water by the public is only incidental. Most of the wells tap the Santa Fe group, but a few of them tap the alluvium.

Following is a list of industrial and commercial wells and estimates of pumpage, grouped according to type of industry and use.

Estimated Use of Water by Industries in the Albuquerque Area

	Number of wells	Average pumpage (gpd)
Electric powerplants	14	1,900,000
Dairies and food-products plants	11	870,000
Iceplants	2	580,000
Laundries	5	260,000
Air-conditioning supply	4	200,000
De-watering	2	1,000,000
Others (various plants)	21	860,000
Totals	62	5,670,000

Electric powerplants use ground water mostly for cooling the exhaust steam from turbines. The water is circulated through cooling towers where much of it is dissipated as vapor. In the process the water is recirculated until its mineral concentration becomes almost great enough to cause incrustation in the cooling towers; at this stage it is discharged to waste. It was reported that about half the cooling water was consumed and that the waste water is discharged into sewers, drains, or ponds. Chemically treated water is used in the boilers and for driving the turbines; but, because this water is used over and over again in a closed circuit, the quantities involved are small.

The use of water by industries other than electric-power is largely nonconsumptive. Water used by dairies and manufacturers of food products serves mostly for washing, and it is discharged as waste into sewers. The use for making ice is almost totally nonconsumptive. The use in laundries is mostly nonconsumptive and the water is discharged into sewers as waste; some water, however, is lost as steam and in the drying process.

Large air-conditioning units for industrial plants mostly are of the refrigeration type. Water pumped from wells is used to dissipate heat from the heating coils and is then discharged into sewers; the use is thus mostly nonconsumptive. These air-conditioning units should not be confused with the evaporative-type coolers which are used extensively in the Albuquerque area and which consume a large amount of water.

Wells used for de-watering are pumped almost continuously to keep the ground-water level low, and the water pumped is not consumed at the site. One such well (12.4.6.212a, table 2) is used to prevent flooding of the lower part of a large lumber-curing kiln; the water is turned into an irrigation canal and most of it is used downstream for irrigation.

Irrigation Supplies

Surface water diverted from the Rio Grande and ground water pumped from wells (table 3) are used to irrigate about 13,500 acres of land. Water is diverted from the river to irrigate about 12,500 acres of land within the Albuquerque Division of the Middle Rio Grande Conservancy District. Tracts totaling about 1,000 acres outside the conservancy district, mostly on the mesas, have no rights to surface water and are supplied with water from a few large wells.

About half the irrigated acreage within the conservancy district can be irrigated from standby irrigation wells in the event of scarcity of surface water. However, some of the wells within the district are used regularly to irrigate land, because the well water is preferred even though surface water is available.

During the inventory of wells, 118 irrigation wells, including 117 large-discharge wells and one small-discharge well, were visited. The measured or reported discharge at 83 of the wells ranged from 240 to 2,000 gpm and averaged 860 gpm. Eighty-eight of the wells, all on the valley floor, are used to supplement the surface-water supply. Twenty-nine of the wells, mostly in areas where the land-surface elevation is above the reach of the gravity-distribution surface-water system, are the only source of irrigation water for the land served.

Many small-discharge irrigation wells are in use in the inner valley in addition to large-discharge irrigation wells. The discharge capacity of the small wells generally is less than 200 gpm per well and the water is used to water gardens, lawns, and small orchards. These wells usually are driven and tap shallow water in the alluvium. Detailed data were not collected for driven wells although several hundred of them were counted; it is believed that there are between 1,000 and 2,000 such wells in the area. The average size of the small irrigated tracts is estimated to be less than an acre.

The quantity of water pumped from wells for irrigation varies from year to year and depends in part on the amount of surface water available. Most of the large-discharge wells are not pumped unless there is a shortage of surface water. Twenty-nine wells which serve as the only source of irrigation water were visited, and it is estimated that about 1,400 acres is irrigated annually from these wells. If, in addition, it is assumed that 1,500 acres is irrigated each year from the many small driven wells, and that 3 acre-feet of water per acre is needed, then 8,700 acre-feet of water is pumped for irrigation each year when supplies of surface water are adequate and standby wells are not used. In addition, about 1,500 acre-feet of water is pumped annually from five wells in sec. 35, T. 9 N., R. 2 E. (table 3), and carried southward by canal to irrigate Indian lands outside the Albuquerque area. Thus a total of 10,200 acre-feet can be considered as about the minimum annual pumpage from irrigation wells in the Albuquerque area.

In the event that an extreme drought should result in a total lack of surface water for irrigation, about 9,000 acre-feet could be pumped from existing standby irrigation wells, which are designed to supply water when needed to about 3,000 acres. The annual pumpage for irrigation from present wells (1960) could range from about 10,000 acre-feet to about 19,000 acre-feet. If additional wells were constructed to provide water for all the 13,500 acres of irrigated land in the area, the annual pumpage could range from about 10,000 to 42,000 acre-feet.

Following is a tabulation of estimated present use of ground water for irrigation in the area during a year of average precipitation.

Estimate of the Number of Irrigation Wells, Quantities of Water Pumped, and Acreage Served During a Year of Normal Precipitation and Stream Runoff, in the Albuquerque Area

Purpose of well	Number of wells	Pumpage ac-ft/yr	Acreage irrigated
Supplemental to surface-water supply			
Large-discharge wells serving project area	83	1,000	3,000
Large-discharge wells serving areas outside the project area	5	1,500	-

Purpose of well	Number of wells	Pumpage ac-ft/yr	Acreage irrigated
Sole source of irrigation water			
Large-discharge wells	29	4,200	1,400
Small-discharge driven wells	1,000±	4,500	1,500
Total	1,100±	11,200	5,900

Domestic and Stock Supplies

Areas not supplied by a public water system obtain water for domestic and stock use from privately owned wells. These wells usually are less than 10 inches in diameter and are equipped with cylinder, jet, or centrifugal pumps driven by a windmill, electric motor, or gasoline engine. They range in depth from a few feet to more than 1,000 feet and they tap either the alluvium or the Santa Fe group, or both. Data were obtained on most of the domestic and stock wells in outlying areas (table 4) where the wells are relatively far apart. However, on the inner valley floor, ample hydrologic data were available from wells of other uses and it was not necessary to visit domestic and stock wells.

The quantity of water for domestic and stock use is small compared with the quantity pumped for other uses. An estimate, made on the assumption that about 50,000 people live beyond the reach of public water systems and that the per capita use of water is about 40 gpd, indicates the daily pumpage to be about 2,000,000 gallons, or about 2,200 acre-feet per year.

About 65 stock wells were visited during the investigation; these generally are equipped with windmill-operated pumps. As many of the windmills are turned off much of the time, and as the wind blows only part of the time, an estimated average daily pumping rate of 1 gpm per well seems reasonable, and the total pumped from all the stock wells would amount to only 0.1 mgd. As the estimates in general are only approximate, this amount is included with the 2.0 mgd attributed above to domestic use.

Summary estimates of ground-water pumpage in the Albuquerque area are tabulated below.

Approximate Pumpage from Wells in the Albuquerque Area

	Acre-feet pumped during 1959	Average daily pumpage, in millions of gallons
Albuquerque municipal supply	37,200	33.2
Water supplies not municipally owned	5,600	5.0
Industrial use	6,400	5.7
Irrigation use	11,200	10.0
Domestic and stock use	2,200	2.0
Total	62,600	55.9

Shape and Slope of the Water Table and Movement of Ground Water in the Valley Fill

The water table, in general, is not level or uniform but is an irregular, sloping surface. The irregularities in the surface are caused by differences in permeability and saturated thickness or by additions or withdrawals of water. The contour lines in plates 1a and 1b show the configuration of the water table and, by inference, the direction of movement of ground water. The ground water moves generally downgradient at right angles to these lines. The water table in cross section is shown in a block diagram of part of the Albuquerque area (fig. 3).

The water table slopes at a low gradient diagonally downvalley from the bases of the Sandia and Manzano Mountains on the east and from the Rio Puerco on the west toward a generally southward-trending zone about 8 miles west of the Rio Grande. The water table along this zone is lower than the water table beneath the inner valley. This depression in the water table, which hereafter will be referred to as "the ground-water trough" or simply "the trough," extends from north to south, through most of the project area, and coincides with the Rio Grande at some point downstream in Valencia County (F. B. Titus, U. S. Geological Survey, oral communication, 1960). A water-table mound, caused by relatively high ground-water levels in the Jemez River valley, crosses the trough in the northern part of the project area (pl. 1b).

Water Table Beneath the East Mesa

The water table slopes generally southwestward from the Sandia and Manzano Mountains at a rate of about 5 to 20 feet to the mile. The gradient is steeper near the mountain fronts and in Tps. 12 and 13 N. where the base of the mountains is only 3 to 4 miles from the valley floor. The steeper slope indicates a greater resistance to the movement of water within the aquifer or, in places, a greater amount of recharge. The greater resistance probably is caused by a reduction in the thickness of the water-bearing materials, as the sediments are similar to those in other areas to the south where the permeability is known to be high. Near the mountain front the bedrock floor is relatively near the surface and the unconsolidated sediments overlying the bedrock are much thinner than in the deeper part of the Rio Grande trough to the west (fig. 3).

The slope of the water table beneath the east mesa is flattest and most uniform in Tps. 9, 10, and 11 where the base of the Sandia and Manzano Mountains is 5 to 10 miles from the valley floor; east of this area, the slope of the water table becomes steeper 1 to 3 miles from the mountain front, probably because of the decreasing thickness of the valley fill in front of the mountains. The gentle and relatively uniform hydraulic gradient beneath the mesa indicates a generally high transmissibility. Aquifer tests in the area indicate transmissibilities mostly between 50,000 and 500,000 gpd per foot for the water-bearing materials (see "Remarks," tables 1, 2, and 3). This high transmissibility is indicated also by the large yields of wells on the east mesa.

Several irregularities in the southwestward slope of the water table (pls. 1a and 1b) are caused by pumping large quantities of water from wells. A depression in the water table in secs. 16, 20, and 21, T. 10 N., R. 4 E., is caused mainly by pumping from well 10.4.16.334 (table 1). The drawdown effects from pumping this well probably are greater than those from pumping a similar well nearer the center of the valley, owing to boundary effects caused by upfaulted, less permeable rocks parallel to the front of the Sandia Mountains. Other depressions centered in secs. 1 and 8, T. 9 N., R. 3 E., also are the result of heavy pumping from wells.

Irregularities in the water table where large quantities of water have not been removed by pumping probably are due to areal changes in permeability. A large depression in the water table extending from sec. 5, T. 11 N., R. 4 E., southwestward to sec. 14, T. 10 N., R. 3 E., probably is the result of a relatively high permeability, at depth, in well-sorted gravel in the Santa Fe group.

Ground water moves from the mesa into the alluvium beneath the inner valley and into drains. Some of it probably underpasses the drains and river and moves into the water table trough beneath the west mesa. Theis (1938, p. 289-291) showed that ground water did not move toward the Rio Grande in the 6-mile reach between Albuquerque and Alameda during 1918-22, before the drains were constructed, but moved southward through the sediments underlying the inner valley in a direction generally parallel to the course of the river.

Water Table Beneath the Floor of the Inner Valley

The slope of the water table beneath the inner valley is approximately the same as the downstream slope of the Rio Grande, and the water table is at or very close to the surface under the river channel. The water-table contours cross the inner valley at about right angles to the trend of the river; however, near the river, the water table slopes sharply toward drains excavated on either side. These, and other drains farther from the river, were designed to lower ground-water levels to about 8 feet below average nearby land levels, and to control the water levels and the shape and slope of the water table beneath most of the inner valley. The river thus flows at a level about 8 feet above the general water table in much of the valley, and water seeps from the river into nearby drains.

The depression in the water table near the center of downtown Albuquerque (pls. 1a and 2a) is the result of heavy pumping from the many wells in the city area and a reduction in local recharge due to quick surface drainage from buildings and paved areas into gutters and sewers. The depression extends about 5 miles north and 2 miles south of the center of the city. The drains crossing the area of the lowered water table apparently are perched above the water table and locally discharge water into the ground-water reservoir instead of draining water away from it.

The water table beneath the inner valley floor and adjacent areas in Tps. 13 and 14 N. slopes toward the Rio Grande from both sides. This convergence of slope is due to the southwestward slope of the water table from the base of the Sandia Mountains on the east and the southeastward slope from the water-table mound underlying the lower part of the Jemez River valley on the west. However, in Tps. 8, 9, 10, 11, and 12 N., the water table slopes toward the inner valley from the east but slopes away from the inner valley floor toward the ground-water trough to the west. In this area the water table beneath the inner valley may be visualized in cross section as a horizontal shelf on a general westward slope, with inflow from the east and outflow to the west. The relative flatness of the water table beneath the inner valley probably is due to a combination of several factors: 1) the average permeability of the alluvium of the Rio Grande is greater than the average permeability of the underlying and abutting Santa Fe group, as indicated by high yields of shallow irrigation wells in the inner valley; 2) recharge on the inner valley floor from irrigation adds water rather evenly to the ground-water reservoir; 3) the system of drains tends to maintain a water table roughly parallel to the land surface, which is relatively flat across the valley.

Ground-Water Trough

The extent of the ground-water trough west of the Rio Grande is poorly defined because points where data could be collected are relatively far apart, and many of the depths to water were reported from memory. Therefore, the shape of the trough is known only approximately and is indicated by dashed contour lines on plates 1a and 1b. In well 10.2.21.343 (table 1), 4 miles west of the Rio Grande at Albuquerque, the measured water level was found to be about 20 feet lower than the water surface of the Rio Grande. The lowest part of the ground-water trough is 30 to 40 feet lower than the river. The part of the trough within the project area is 6 to 10 miles wide and 30 miles long, and includes an area of about 250 square miles.

The ground-water trough may be caused by one or more conditions. 1) The Santa Fe group may be thickest under the water-table trough, thus providing more conduits through which the water can move. 2) The permeability of the Santa Fe group may be greatest in the area along the axis of the trough. A greater permeability along a strip of the aquifer could result from the presence of an ancient channel deposit of the Rio Grande, composed of highly permeable sand and gravel, which could function as a drain for the aquifer. However, according to data collected, no extremely permeable and extensive beds are known in the area of the ground-water trough, although such beds may exist at depths greater than existing wells. 3) Movement of ground water in the area west of Albuquerque may be governed, in part, by differences in the amount of average annual recharge to various sectors of that area. Low recharge on the west mesa could cause ground water to move toward the central part of the west mesa from areas of greater recharge east and west of the mesa. The ground-water trough may be caused by a combination of these conditions; however, data from which to draw a firm conclusion about the origin of the trough are inadequate.

Water Table Between the Ground-Water Trough and the Rio Puerco

The water table in the western part of the project area slopes eastward to southeastward from the Rio Puerco valley toward the ground-water

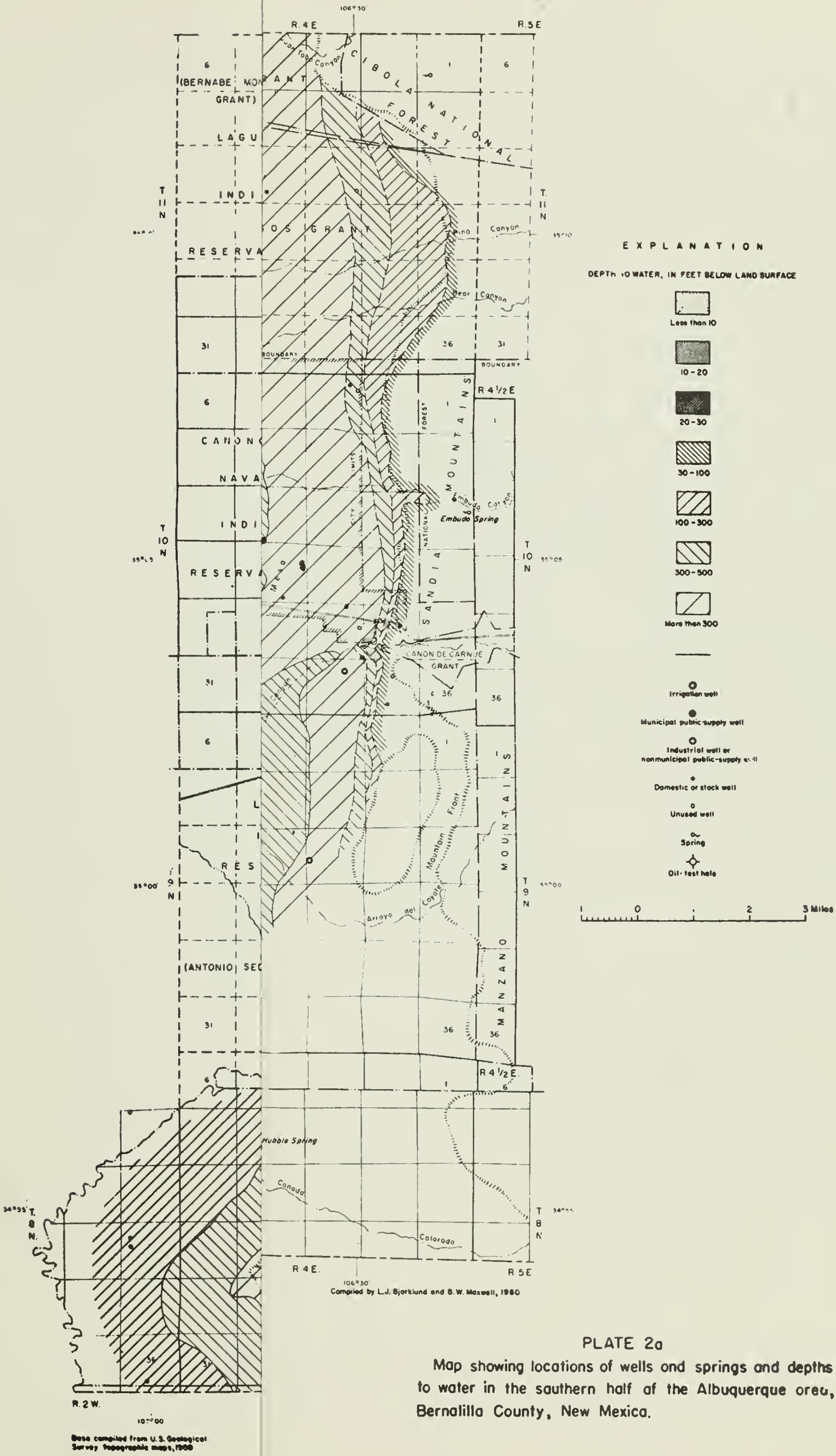


PLATE 2a

Map showing locations of wells and springs and depths to water in the southern half of the Albuquerque area, Bernalillo County, New Mexico.

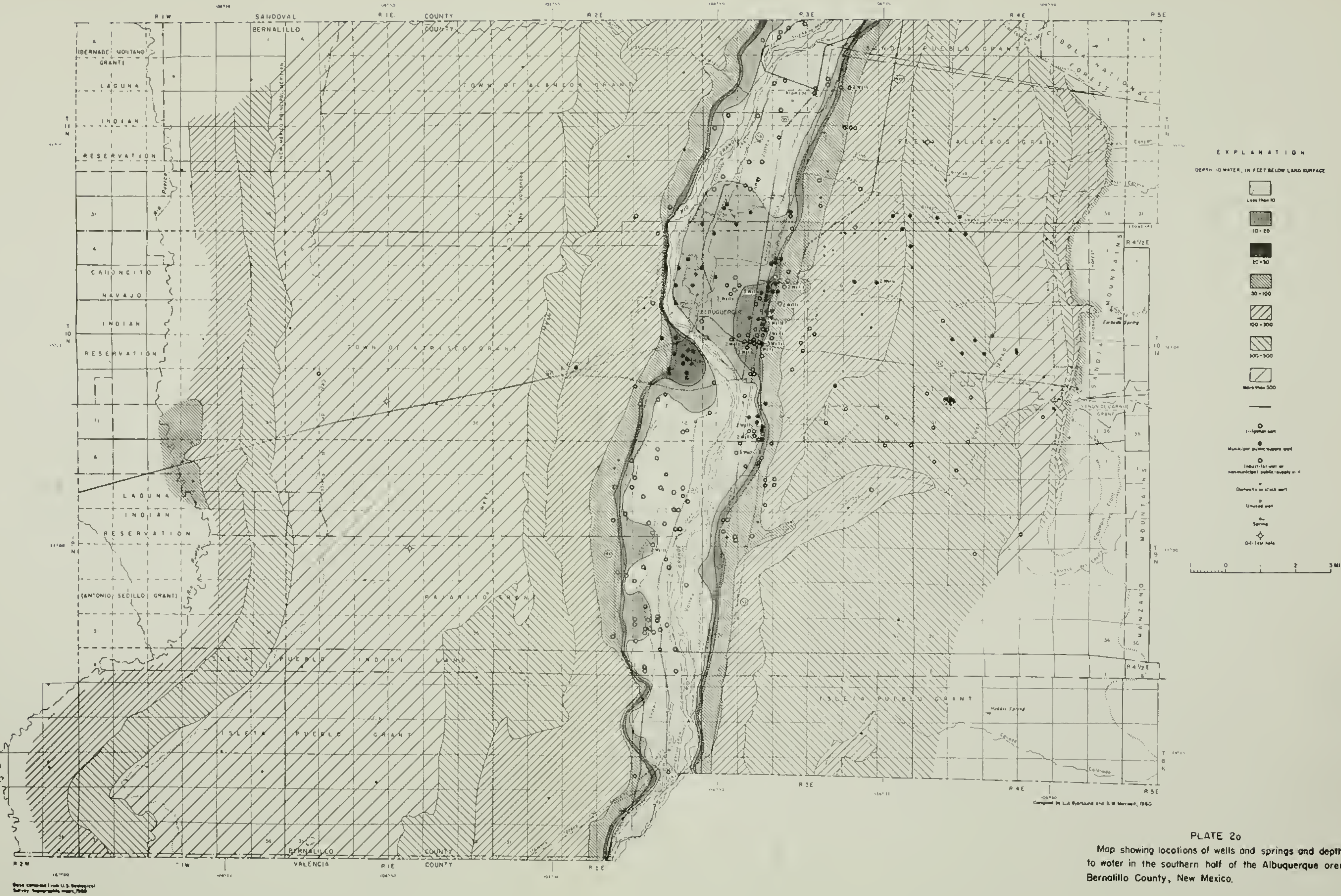
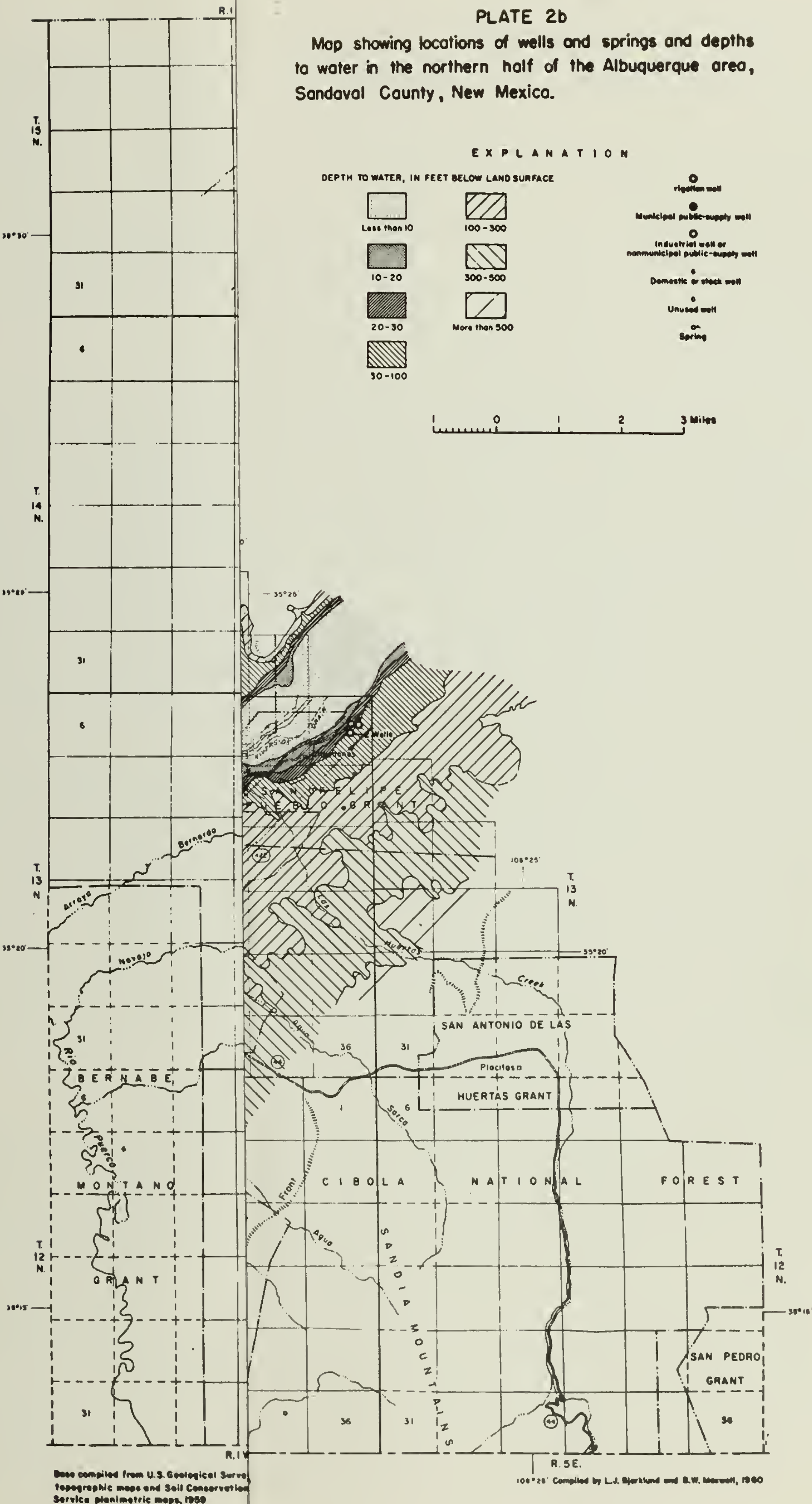


PLATE 2a

Map showing locations of wells and springs and depths to water in the southern half of the Albuquerque area, Bernalillo County, New Mexico.

PLATE 2b

Map showing locations of wells and springs and depths to water in the northern half of the Albuquerque area, Sandoval County, New Mexico.

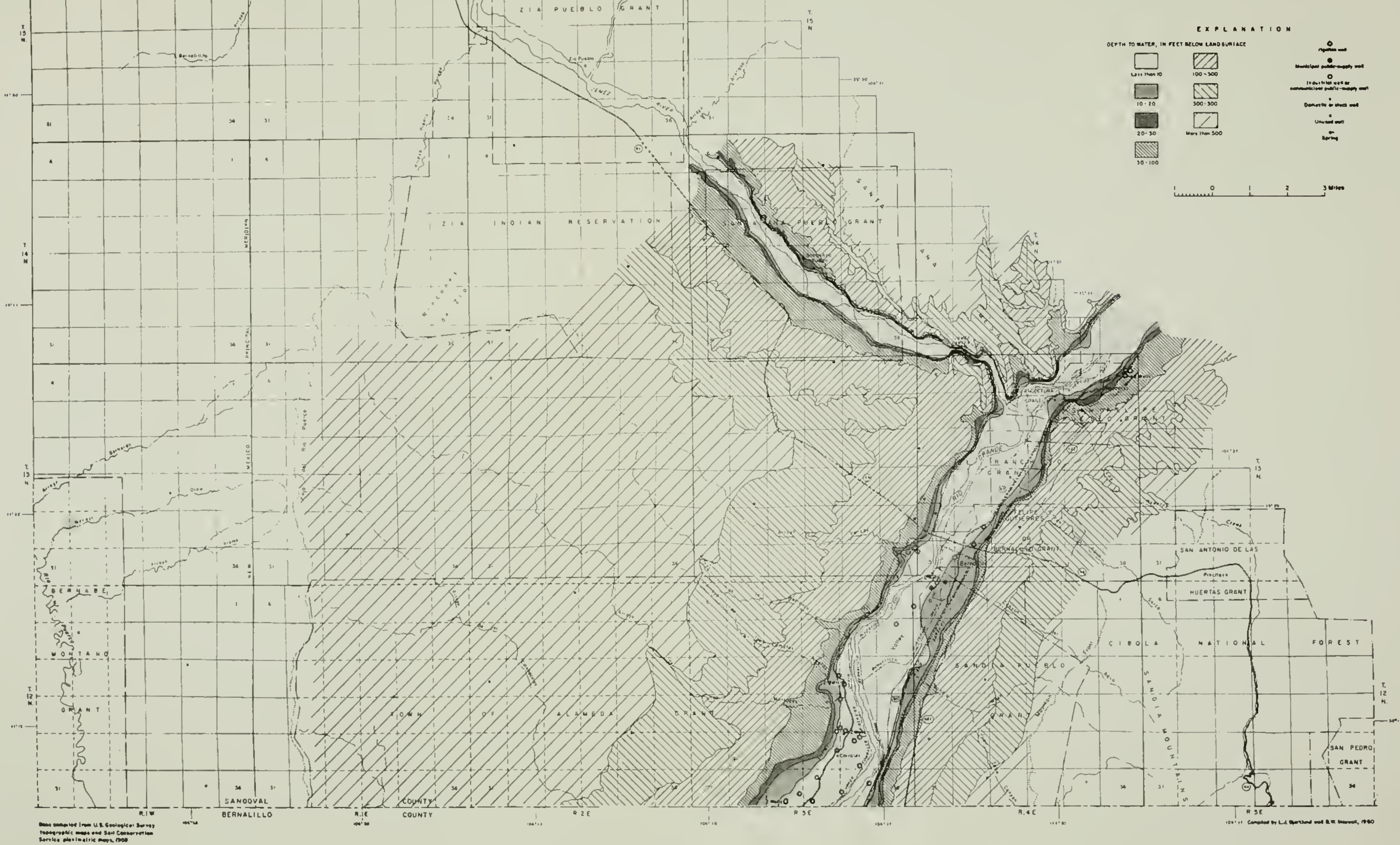


Base compiled from U.S. Geological Survey topographic maps and Soil Conservation Service planimetric maps, 1959

106°25′ Compiled by L.J. Bjorklund and B.W. Maxwell, 1960

PLATE 2b

Map showing locations of wells and springs and depths to water in the northern half of the Albuquerque area, Sandoval County, New Mexico.



trough; the slope is steeper than slopes elsewhere in the project area, presumably because the water-bearing materials are less permeable. The water level in well 10.1.30.222 (table 2), for instance, on the west rim of the west mesa, drew down 64 feet at a pumping rate of 32 gpm. The permeability of the Santa Fe group generally is lower in the western part of the project area than it is in the eastern part because much of the sediment in the western part is derived from rocks of Mesozoic age which contain much silt and clay; on the other hand, the rocks derived from the Sandia and Manzano Mountains on the east side of the area consist mostly of sand and gravel.

Water-Table Mound Beneath the Jemez River Valley

A mound on the water table in the valley fill underlies the lower part of the Jemez River valley and is indicated by the contours on the water table (pl. 1b) in the 12-mile reach above the confluence of the Jemez River and the Rio Grande. The mound is the result of the combined effects of recharge from the Jemez River and of the probably relatively low permeability in the upper part of the valley fill due to deposition of fine-grained sediments by the Jemez River. The high water table beneath the Jemez River may be perched above the main water table in the Rio Grande valley, but no evidence of a perched water table was observed or reported. It is more likely that all the valley fill beneath the water-table mound is saturated.

Some water at depth in the Santa Fe group may be passing beneath the water-table mound because a ground-water trough in the area west of the Rio Grande exists north of the Jemez River water-table mound as well as south of it. Greater permeability in the deposits at depth along the projected axis of the ground-water trough than in the near-surface deposits beneath the water-table mound would make it possible for ground water to move in a southerly direction under the water-table mound. More probably, however, the trough in the water table to the north of the Jemez River terminates at the Rio Grande north of the Jemez River and would not be related to the trough to the south of the Jemez River.

Fluctuations of the Water Table

The water table fluctuates as water is added to or withdrawn from the underground reservoir. Water-level fluctuations in wells may be brief, seasonal, or long term. Heavy precipitation and irrigation by surface water diverted from streams tend to raise the water table, and drought and pumping from wells tend to depress it.

The discussion of water-table fluctuations in the Albuquerque area is based mainly on periodic water-level measurements made manually at 38 wells and on recording-gage records made at six wells. Hydrographs of three wells equipped with recording gages are shown in figure 7. Summaries of selected data are published annually by the New Mexico State Engineer and at 5-year intervals by the U. S. Geological Survey.

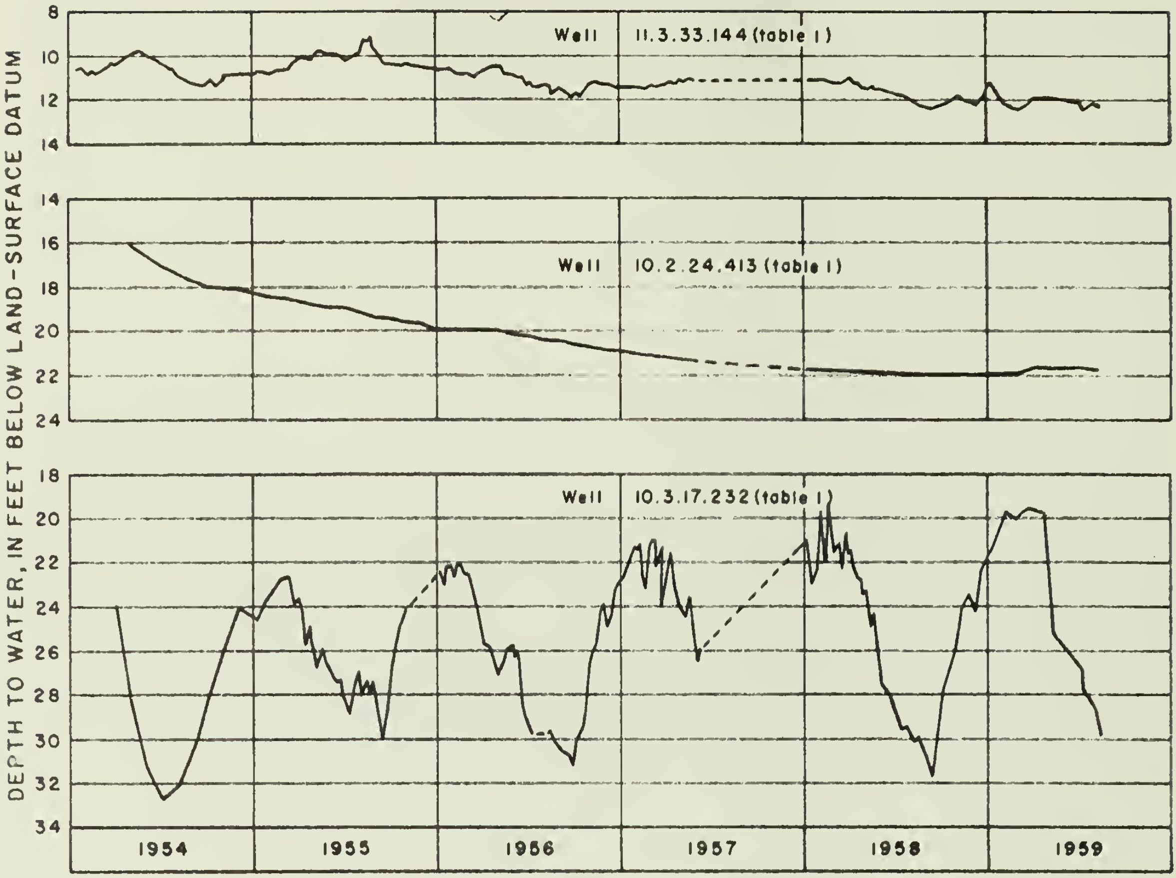


FIGURE 7. -- Hydrographs of three wells equipped with recording gages in the Albuquerque area, N. Mex.

Seasonal Fluctuations

Seasonal fluctuations of water levels in wells in the Albuquerque area generally are of two types: 1) water levels that are highest in summer and lowest in winter, and 2) water levels that are highest in winter and lowest in summer. Summer high water levels are characteristic in areas in the inner valley where land is irrigated by water diverted from the Rio Grande or where inundation by flood runoff is common. (See hydrographs of wells 8.2.2.143 and 10.3.20.214, figure 8.) Water levels in the irrigated areas usually are highest during late summer immediately after the irrigation season, and lowest in early spring before the first application of irrigation water. Between irrigation seasons water levels decline slowly as the accumulated ground water moves through the water-bearing materials toward the drains.

Fluctuations of water levels are quite consistent from year to year in areas where diverted river water is used for irrigation and where drains have been constructed, because the range of water levels usually is limited

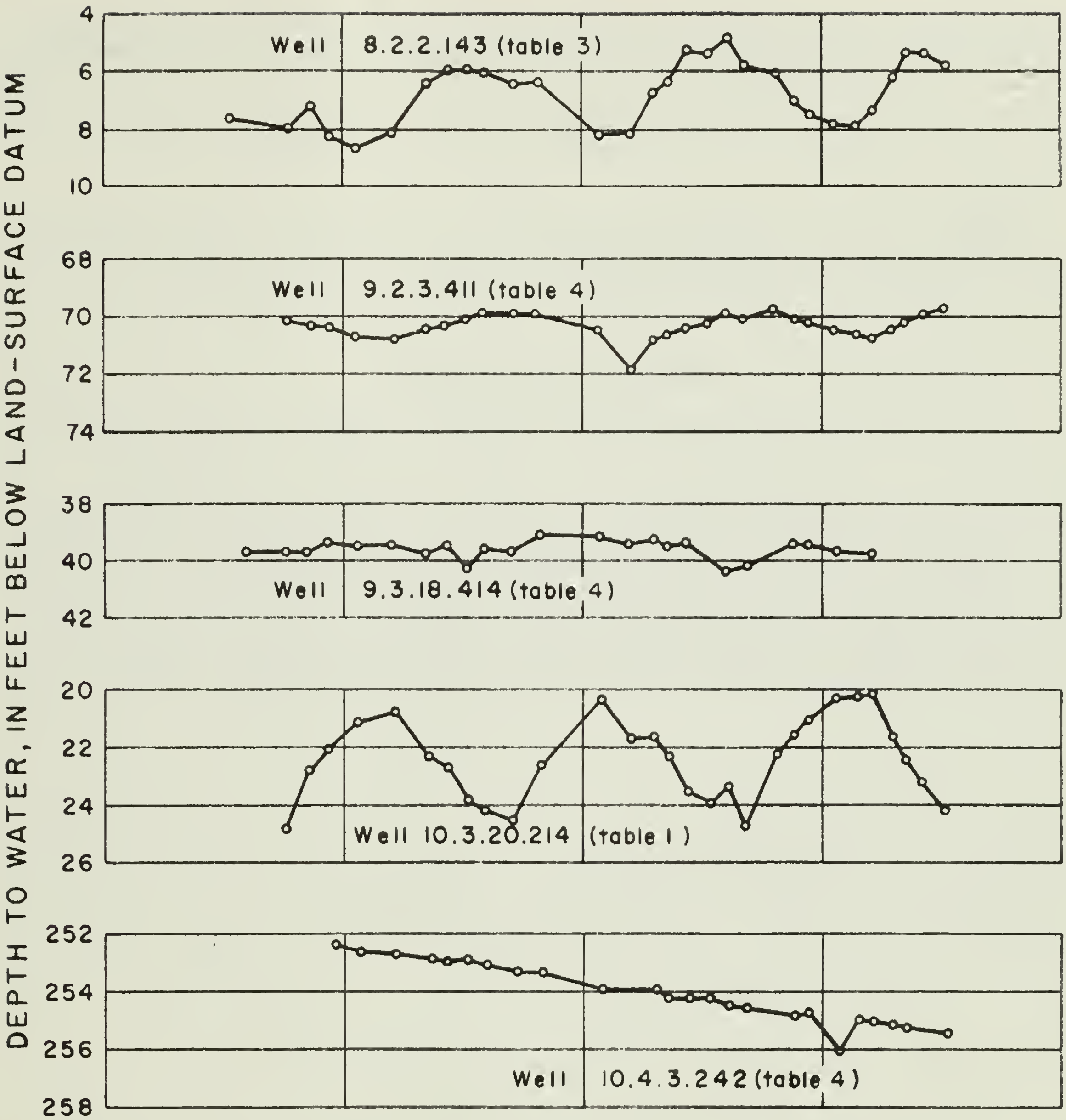


FIGURE 8. -- Hydrographs of five wells in the Albuquerque area, N. Mex.

by the level of the land surface above and the level of the drains below. These limits are seldom reached because the higher the water level the more rapidly the ground water moves toward the drains; and, conversely, the lower the water level the more slowly the ground water moves toward the drains. For these reasons water levels during or after a wet season, when much surface water is available and is diverted for irrigation, are only slightly higher than during an average season.

Summer low water levels are found most commonly in areas where large amounts of water are pumped from wells during the summer, and lesser amounts, or none, are pumped during the winter. These summer low water levels are characteristic in areas where irrigation water is obtained exclusively from wells and in areas where large amounts of water are pumped for public supplies.

Summer low water levels occur also in places in the inner valley near the Albuquerque municipal-supply wells, where the effects of heavy summer pumping are greater than the effects of recharge from irrigation.

Long-Term Fluctuations

Several wells in the Albuquerque area show changes in water level that extend over a period of years. These fluctuations, although not great, can be tied to definite causes. The decline in water level in wells 10.2.24.413 and 11.3.33.144 (table 1 and fig. 7) is caused by heavy pumping from municipal and industrial wells in downtown Albuquerque and neighboring areas. In places in the downtown area the long-term lowering has amounted to about 20 feet. The fluctuations of the water level in well 9.1W.4.432 (table 4 and fig. 9) in the Rio Puerco valley correlate with the record of precipitation; the years of deficient rainfall, 1950-54, are indicated by a lower water table. The general decline shown by hydrographs

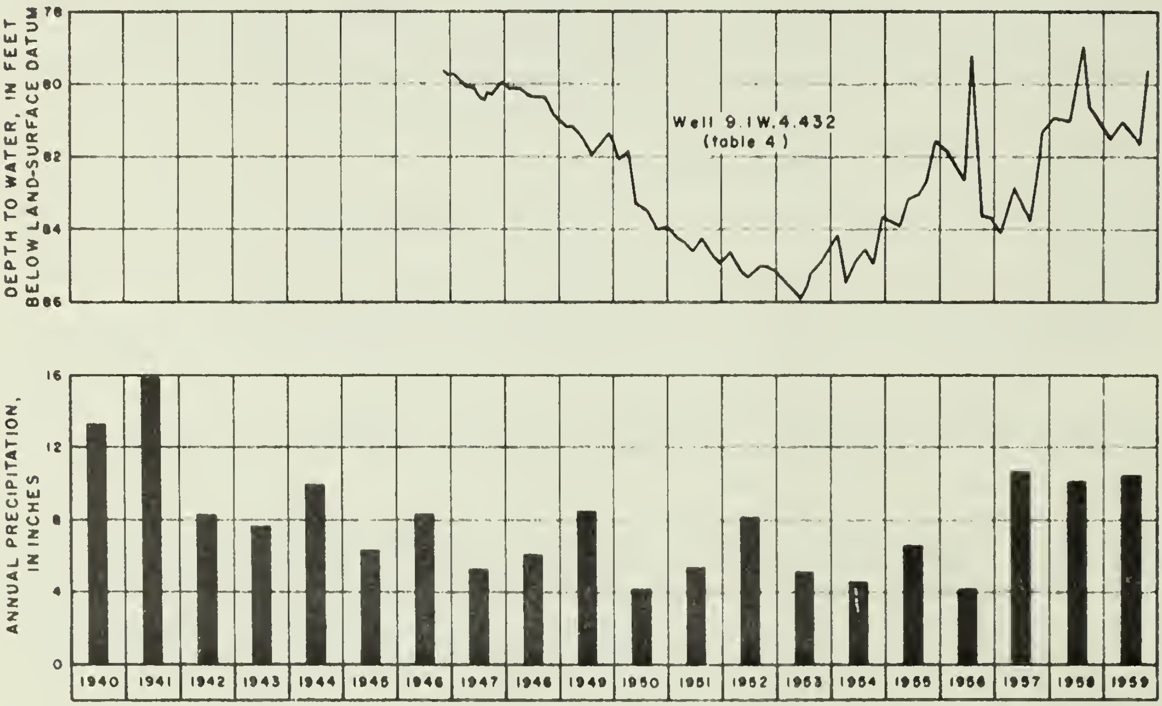


FIGURE 9. -- Graphs of water level in well 9.1W.4.432, 1947-59, and annual precipitation at Albuquerque, N. Mex., 1940-59.

of well 10.4.3.242 (table 4 and fig. 8) may be due to pumping from other wells, although this well is about 3 miles from areas where pumping is heavy.

Water levels beneath the inner valley have lowered significantly since the construction of drains began in 1930. The water table declined 2 to 4 feet in the period 1927 to 1936 in the reach of the valley between Algodones and Isleta (Theis, 1938, p. 272). The water table has lowered an additional 2 feet since 1936, according to a comparison of a water-table contour map prepared in 1936 (Nat. Resources Comm., 1938) and a water-table map prepared in 1960 (pls. 1a and 1b). The decline since 1936 may be attributed to 1) more time for drainage, 2) subsequent improvement and extension of drainage system, and 3) increased pumping. A comparison of the two maps indicates a lowering of the water table of more than 10 feet, near downtown Albuquerque.

The water-table depression beneath Albuquerque probably will continue to decline and expand as the city grows and the use of water increases. The decline will continue until equilibrium is reached between pumping effects and recharge of irrigation, return from city pumping, and seepage from the Rio Grande and drains. After an equilibrium is reached at a given rate of withdrawal, each increase in withdrawal will require establishment of a new equilibrium at a lower position of the water table.

Declines in the water table greater than those in the downtown area may be expected in the vicinity of heavily pumped wells on the mesa, as the wells are farther from the Rio Grande and are not affected by sources of replenishment such as irrigation return. The declines probably will be greatest in well fields nearest the Sandia and Manzano Mountains because of the boundary effects of the adjacent impermeable bedrock. Inasmuch as most of the wells constructed on the east mesa have been in production for only a short time, the general decline in the water table has not yet been appreciable (fig. 3).

Depths to Water

Depths to water between wells used as control points were determined by subtracting the altitudes of ground-water levels, as indicated by water-table contours, from altitudes indicated by land-surface contours at points where the contours intersected. The relation of the depth to water and of water levels to surface topography and geology is illustrated by a section across the Rio Grande valley and part of the Rio Puerco valley in the block diagram of figure 3.

Beneath the Inner Valley

The depth to water in most of the inner valley is between 5 and 10 feet but in a few places it is less than 5 feet. Water levels generally are kept at depths greater than 5 feet by drains constructed by the Middle Rio Grande Conservancy District. During 1926 and 1927, before the drains were constructed, the water table was less than 4 feet below land surface in 60 percent of the Algodones-Bernalillo area, less than 2 feet below land surface in 60 percent of the Alameda-Albuquerque area, less than 3 feet below land surface in 60 percent of the Corrales area, and less than 3 feet below land surface in 60 percent of the Atrisco-Isleta area; the water level stood at the land surface in parts of all the above-mentioned areas (Theis, 1938, p. 272-274).

The depth to water beneath downtown Albuquerque and adjacent areas has increased substantially during recent years, owing to pumping from wells and the reduction of recharge resulting from installation of buildings, streets, and sewers. The water table is lowest beneath the part of the downtown section of the city where little or no water seeps from the land surface to the ground-water reservoir; here depths to water range from about 20 to about 29 feet (pl. 2a) and a closed depression has formed. The area of the depression is indicated by the zones indicating depths to water of 10 to 20 and 20 to 30 feet.

Beneath the Mesas

The depth to water increases from the inner valley eastward on the east mesa and westward on the west mesa because the land surface slopes upward from the inner valley at a steeper gradient than does the water table (fig. 3). The depths beneath the east mesa increase from about 10 feet at the east edge of most of the valley floor to about 600 feet at places in front of the Sandia and Manzano Mountains. Near the mountain front, at distances of generally less than a mile, the depth to water decreases rapidly eastward (toward the mountains), as the gradient of the water table increases because of a lesser thickness of water-bearing materials in the Santa Fe group. Here the Santa Fe materials are deposited on fault blocks which are relatively near the land surface (fig. 3).

A local perched-water zone was discovered in the Santa Fe group when well 10.4.34.214 (table 3) was drilled to a depth of 1,200 feet. The water level of the perched zone is about 350 feet below the land surface; water could be heard cascading down the well to the water level of the main saturated zone, which is at a depth of 616 feet. The altitude of the perched water table is about the same as the water level in well 10.4.27.444 (table 4), about 0.3 mile away, and it is probable that the water table at this well also is perched. Perched ground-water zones probably occur locally in the Santa Fe group at many places because of bodies of silt or clay that retard the downward movement of water from the land surface. However, it is unlikely that extensive perched ground-water zones exist within the project area because bedding in the Santa Fe group generally is lenticular and random rather than uniform over large areas.

The depth to water increases westward from the west edge of the inner valley because the land slope is eastward and the water-table slope toward the trough is westward. The depth to water in the Rio Puerco valley increases eastward because the land-surface slope is westward and the water-table slope toward the trough is eastward.

The depths to water in the Albuquerque area are greatest beneath the west mesa, where the water levels are reported to range from about 800 feet to about 1,000 feet below the land surface. The range in depth is due partly to the ground-water trough beneath the west mesa and partly to variations in the altitude of the land surface.

Beneath the Jemez River Valley

Depths to water in the lower part of the Jemez River valley are shallow. The water table is shallowest along the river channel, where ground water usually is near or at the land surface. The depth to water increases both northward and southward from the streambed because the altitude of the land surface increases and the altitude of the water table decreases (pls. 1b and 2b). Depths to water increase consistently to the south, and the water table apparently is continuous with that beneath the west mesa; however, the depth to water north of the Jemez River increases more abruptly. The water level reported in well 14.3.3.433 (table 4), about 2 miles north of the Jemez River, is 585 feet below the land surface and about 100 feet below water levels beneath the river. This may indicate a northward extension of the ground-water trough north of the Jemez River valley.

Recharge to the Ground-Water Reservoir

Recharge is the addition of water to the ground-water reservoir. The source of such water is precipitation; seepage from streams, drains, canals, surface reservoirs, and applied irrigation water; and underflow of ground water from adjacent areas. All these types of recharge are important in the Albuquerque area, the order of their importance depending on local conditions.

Recharge from Precipitation

Recharge directly from precipitation can occur readily in places where the materials at the surface of the land are highly permeable, such as sand dunes, sandy bottomed ephemeral stream channels, rubble-covered slopes, and scoriaceous lava flows. Other factors controlling recharge directly from precipitation include the duration and intensity of the precipitation and seasonal weather conditions that affect soil temperatures and the growth of vegetation. A light summer shower will contribute nothing to the zone of saturation, even though it falls on sandy soil, but a light shower in winter may result in recharge because evaporation rates are low and vegetation is more or less dormant at that time. Little or no recharge can occur if the ground is frozen. Recharge directly from precipitation may be indicated by a rising water table soon after a rain, in places where the water table is near the land surface, such as in the inner valley.

It is probable that much of the water that falls on the sand dunes along the Jemez River in T. 14 N., R. 3 E., especially in secs. 20 and 21, percolates to the water table, which is generally less than 30 feet below the land surface. Sand dunes occur also along the west rim of the west mesa overlooking the Rio Puerco valley, and at the east edge of the west mesa where it overlooks the floor of the river valley; however, these dunes generally are scattered and are relatively small, and thus the volume of water received directly from precipitation upon the dunes also is relatively small. Roots of the vegetation that covers some older sand dunes intercept precipitation before it can reach the water table.

The lava flows and scoriaceous beds of cinders around the volcanos on the west mesa are exceptionally permeable and readily transmit water down toward the zone of saturation. The rubble and loose, coarse-grained weathered rock along the base of the Sandia and Manzano Mountains is believed to receive and transmit to the water table a relatively large part of the precipitation that falls on the west slopes. The sandy washes and arroyos that drain the mountain front, and also the west mesa, have a high potential for recharge and serve as important areas of recharge to the ground-water reservoir.

Infiltration Capacity

The infiltration capacity of the surface and near-surface material was determined at four locations incidental to pumping tests. The values determined ranged from 1.6 to 13.7 acre-feet per acre per day; the overall range in infiltration capacity in the project area probably is much larger. The greatest infiltration rates were observed in borrow pits where the water was in contact with freshly exposed sediments and under a hydraulic head of a few feet. The smallest infiltration rates were measured in places where the surficial material was a fine-textured soil.

Rates of seepage from the land surface of about 2.0 and 1.6 acre-feet per acre per day were measured in areas west of wells 10.4.20.244 and 10.4.20.143 (table 1) respectively. When well 10.4.20.244 was test-pumped, water was discharged into a shallow depression sloping westward at approximately 70 feet per mile. The depression was covered with soil and a relatively thick growth of weeds. The water ran down the slope readily but ceased to flow on the land surface at distances downstream that depended on the rate of pumping. A pumping rate of 1,800 gpm, or 4 cfs, was maintained during the last 22 hours of the test. At the end of the test the lower end of the wetted area was stationary 3,780 feet west of the well and had been at the same position for several hours. The wetted area covered 3.85 acres. Inasmuch as the area was not changing, the loss by seepage, evaporation, and transpiration was approximately equal to the amount of the pump discharge, which was 7.93 acre-feet per day, or 2.06 acre-feet per acre per day. Evaporation losses were estimated to be about 0.03 acre-foot per day, and transpiration losses were estimated to be roughly similar. It was concluded, therefore, that seepage into the soil, and ultimately to the ground-water reservoir, amounted to 2 acre-feet per acre per day under the conditions described.

When well 10.4.20.143 (table 1) was test-pumped, discharge water was conducted in an excavated ditch to a tributary of Embudo Arroyo. The water flowed for about the first mile in a narrow channel that contained little or no loose sand and gravel and for the remaining distance in a flat streambed about 10 to 20 feet wide which contained some sand and gravel. The wetted area was 16,955 feet long and relatively narrow, usually no more than 2 to 10 feet wide. The well was pumped steadily for 22 hours and the rate for the last 12 hours was 2,300 gpm, or 10.2 acre-feet per day. The wetted area covered 6.2 acres. The average rate of infiltration from the wetted reach of the stream was estimated to be 1.6 acre-feet per acre per day, but the rate doubtlessly varied from place to place with varying conditions in the streambed. Infiltration was inhibited in several places by rubbish and also at a place where a concrete-mixing company used the arroyo to dispose of waste portland cement. It is not known to what extent the cement filled void spaces and impeded infiltration in the materials underlying the streambed.

Most floods in arroyos that contribute to infiltration are brief -- usually lasting only a fraction of a day. The amount of infiltration during a flood in an arroyo is partly dependent also on the scouring action of the flood; disturbance of the sediments on the streambed generally aids infiltration.

A pit 4 feet deep, 21 feet long, and 2 to 7 feet wide was created by the hydraulic action of the discharged water when well 10.4.20.244 (table 1) was test-pumped. The rate of decline of the water level in the pit, following 27 hours of pumping, was measured at intervals for 7 hours. During the 7 hours the water surface declined 3.1 feet at approximately a constant rate. The infiltration rate thus indicated is 10.6 acre-feet per acre per day. However, as the water was moving out of the pit under a head of 1 to 2 feet and also out the sides of the pit, the computed infiltration rate is higher than the infiltration capacity measured under a unit head. Further, the infiltration capacity of these sediments probably is somewhat higher than average because of the lesser amount of very fine-grained material at the site.

Rates of infiltration ranging from 10.0 to 13.7 acre-feet per acre per day were observed in a pit excavated for use in dissipating waste water from an industrial plant. The pit, which covers an area of about 12,000 square feet, is dug into a deposit of coarse sand and gravel which extends to some depth below the bottom. Water was pumped from well 11.3.23.111 (table 2) for 51 hours at an average rate of 1,370 gpm. During the pumping, some water was released from the pit from time to time to prevent the water from getting too high on the unstable banks of the pit. When pumping was stopped, the rate of decline of the water standing in the pit was determined by means of a staff gage standing in the water. The maximum rate of decline was 0.57 foot per hour and was approximately constant between the highest gage reading of 5.57 and a reading of 3.39. Below a gage reading of 3.39 the rate of decline decreased slightly to about 0.42 foot per hour at a gage reading of 0.95. These rates of decline are equivalent to infiltration rates of 13.7 to 10.0 acre-feet per acre per day, the rate changing in response to the changing head of the water in contact with the sand and gravel.

Recharge from Streams

Much recharge to the ground-water reservoir comes from streams. The only perennial flow is that in the Rio Grande, but recharge occurs also from such ephemeral streams as the Rio Puerco and Jemez River, and from many canyons and arroyos.

Rio Grande

The channel of the Rio Grande in most of its reach through the Albuquerque area is not entrenched into the inner valley but has been built up by sedimentation to an elevation approximately level with, and in some places slightly above, the inner valley floor. Consequently, the river flows at the level of the general land surface and is higher than the water table on either side because the water table generally is kept a few feet below the land surface by drains. Because the bed of the river is above the water table of the adjacent land, the river loses water by downward movement. As the water table builds up under the riverbed, the water spreads out. Some is intercepted by drains which conduct it back to the river downstream; some of it is consumed by the transpiration of plants; and some underpasses the drains and moves into other areas.

Jemez River

The Jemez River is perennial in its upper reaches but flows only intermittently or ephemerally in the 20-mile reach above the junction with the Rio Grande. The lower reach of the river usually contains water during the late fall, winter, and early spring months but usually is dry, except for floods, from early June through September. Perennial and intermittent flow in the river comes mostly from snowmelt in the Jemez Mountains and effluent ground-water discharge, whereas ephemeral flow originates from rainstorms within the river's drainage basin. Flow in the lower reach of the river contributes to the ground-water reservoir in the Albuquerque area through infiltration of water into underlying sediments. The streambed is composed mostly of sand which overlies sands and gravels of the Santa Fe group; consequently much water seeps from the streambed into the underlying materials.

Large flash floods at Santa Ana Pueblo, in sec. 21, T. 14 N., R. 3 W., reportedly failed to reach the gaging station 5.5 miles downstream from Santa Ana Pueblo, below Jemez Canyon Dam. Floods of short duration that occur during dry, hot weather, when the sandy riverbed is dry, are largely absorbed by the underlying sediments.

The water table beneath the streambed probably rises to coincide with the stream during periods of continuous flow. When this condition is reached the infiltration decreases to what is needed to maintain the water-table mound beneath the streambed.

The amount of water lost from the stream was estimated from flow records. From April 15 through May 20, 1956, the mean daily flow at Santa

Ana Pueblo was 55.2 cfs, whereas the flow at the gaging station below Jemez Canyon Dam, 5.5 miles downstream from Santa Ana, averaged 44.4 cfs. The loss due to infiltration and evaporation in the 5.5-mile reach thus was 10.8 cfs, or about 2.0 cfs per mile. The wetted streambed was reported to range from 100 to 200 feet in width when the flow was about 50 cfs. The rate of evaporation from a Class A Weather Bureau pan at Jemez Dam for the 36-day period ranged from 0.23 to 0.62 inch per day and totaled 13.71 inches, or about 0.38 inch per day (U. S. Weather Bureau, 1956, Climatological data, New Mexico, p. 60, 76). The evaporation from open-water surfaces larger than the land pan is less than the measured rates. The correction coefficient for this area is not known but probably it is between 0.6 and 0.9. Thus, if the average width of the wetted area of the stream is 150 feet, the evaporation loss during periods of continuous flow would be roughly 0.2 to 0.3 cfs for each mile of the 5.5-mile reach, and the loss by infiltration would be 1.7 to 1.8 cfs per mile. Geologic conditions are similar along the lowermost 20 miles of the Jemez River; and if infiltration averages about the same, then about 35 cfs is lost by infiltration during periods of continuous flow.

Ephemeral Streams

The beds of most ephemeral streams in the Albuquerque area consist of sand and gravel several feet thick which become saturated during flash floods. Some of the water is evaporated after the flow ceases but much of it seeps into the underlying alluvium and Santa Fe group. Small floods in the arroyos usually fail to reach the inner valley because the flow is lost to the underlying sediments. Only the larger drainage channels, such as the Rio Puerco, Jemez River, Tijeras Arroyo, and Arroyo de las Calabacillas (fig. 1), reach the Rio Grande; most of the smaller channels lose their identity on the mesas or on the inner valley floor before reaching the river. The width and depth of the channels of many of the ephemeral streams decrease progressively downstream. The bottom of Tijeras Arroyo, for example, is more than 100 feet wide near the mountain front; but it is only 5 to 10 feet wide where the channel reaches the inner valley (fig. 10).

An unnamed arroyo in the SE¼ sec. 18, T. 10 N., R. 2 E., has a channel 50 feet wide; the same arroyo has a channel only 10 feet wide 2 miles downstream in the NE¼ sec. 21 (fig. 11). The stream channel disappears entirely less than a quarter of a mile farther east. The gradient of the arroyo in this 2-mile reach ranges from 150 to 200 feet to the mile; consequently, the flow of water is rapid and the length of each period of flow is short. The loss by evaporation and transpiration during the short time interval should be negligible; hence it is concluded that virtually all the streamflow that developed the 50-foot-wide streambed in the upper part of the arroyo infiltrates before reaching the lower part of the stream course.

Water infiltrates rapidly into the alluvial fans at the mouths of the many canyons draining the west slope of the Sandia and Manzano Mountains. The logs of wells on the east mesa indicate that the deposits are course and permeable and capable of absorbing precipitation rapidly. It

(a) Looking upstream eastward in the $NW\frac{1}{4}$ sec. 34, T. 10 N., R. 4 E., half a mile west of the Sandia-Manzano mountain front.

(b) Looking upstream eastward in the $SE\frac{1}{4}$ sec. 19, T. 9 N., R. 3 E., at the edge of the inner valley.

FIGURE 10. -- Views of Tijeras Arroyo showing a downstream decrease in the size of the channel along an 11-mile reach of the stream because of seepage loss from floodflow.

(a) Looking downstream eastward in the SE$\frac{1}{4}$ sec. 18, T. 10 N., R. 2 E.

(b) Looking downstream eastward in the NE$\frac{1}{4}$ sec. 21, T. 10 N., R. 2 E.

FIGURE 11. -- Views of an unnamed arroyo on the west mesa showing the downstream decrease in the size of the channel because of seepage loss from floodflow along a 1$\frac{1}{2}$-mile reach of the channel.

is noteworthy that runoff from the flat areas of the mesa usually occurs only when precipitation is exceptionally heavy, and that within a short period of time -- even after heavy precipitation -- little water is observed standing on the surface.

The fact that water levels in wells tapping the Santa Fe group under the east mesa stand at elevations generally 40 to 50 feet higher than water levels in the same group beneath the inner valley floor is evidence that much water is added to the ground-water reservoir along the mountain front and on the mesa. The 40- to 50-foot difference in elevation of the water table results in hydraulic gradients ranging from 5 to 20 feet per mile. If the average transmissibility of the Santa Fe group between the Sandia Mountains and the valley floor is about 100,000 gpd per foot, and if the average gradient of the water table is 10 feet to the mile, the flow of water to the valley from the east mesa along each 1-mile reach of the valley would amount to about 1,000,000 gpd, or 1.5 cfs, or 700 gpm.

Drains

Water in drainage ditches in the project area is a local source of recharge to the ground-water reservoir at times. The principal area where recharge from drainage ditches takes place is in the vicinity of Albuquerque where the depth to water is more than 10 feet (pl. 2a). Seepage from drains to the water table also is induced at places by pumping from wells near the drains. If pumping from a well lowers the water table surrounding the well to a position below the drain, water will move from the drain toward the pumped well. The water table usually will rise after the cessation of pumping and water will again discharge to the drain.

Recharge by Subsurface Inflow

Ground water moves from upstream through the saturated materials of the Santa Fe group and the alluvium into the project area. It moves down the valley at a gradient approximately equal to that of the Rio Grande. The average gradient of the Rio Grande in the upper 6 miles of its reach through the area is 6.7 feet per mile. If the average coefficient of transmissibility of the valley fill -- which includes the Santa Fe group and the alluvium -- is about 200,000 gpd per foot, and if the permeable part of the fill is 20 miles wide, the quantity of ground water moving into the area would be about 26,000,000 gpd, 41 cfs, or 18,000 gpm. This figure is only approximate and does not indicate more than the general order of magnitude because the value of the coefficient of transmissibility is an estimate based on a number of scattered pumping tests and may be considerably different from the true average. Water moving into the project area from adjacent areas through formations other than the valley fill undoubtedly is negligible owing to the relatively low transmissibility of those formations. A quantity of water similar to that entering the area at the upstream side by subsurface inflow presumably is leaving the area at the downstream side by subsurface outflow.

Recharge by Irrigation Return

The source of greatest recharge probably is the infiltration of water diverted from the Rio Grande for irrigation. Recharge from this source is limited to the valley floor. Water diverted from the Rio Grande seeps to the ground-water reservoir from canals, ditches, and fields, and usually causes the water levels in wells in the irrigated area to rise during the irrigation season.

Irrigators usually apply about 3 acre-feet of water per acre per year to most crops; alfalfa, however, usually requires more than 4 acre-feet per acre. These amounts are several times the average annual precipitation, but the recharge effects are proportionately even greater than the direct recharge from precipitation because of the amount of water that is applied at each irrigation. The amount of water that the soil retains before it will pass water downward to the water table is small and is readily satisfied by irrigation, making it possible for a higher proportion of the water to percolate downward to the ground-water reservoir. According to the National Resources Committee (1938, p. 368) the average annual consumptive use of water on irrigated land in the Albuquerque area is 2.7 acre-feet -- 4 acre-feet by alfalfa, 2.5 acre-feet by native hay and pasture, and 2.0 acre-feet by miscellaneous crops. The amount of water applied to the land less the consumptive use is equal to the recharge. Probably about a third of the water applied to the land on the inner valley floor, where the water table generally is less than 10 feet below the land surface, percolates to the ground-water reservoir.

Infiltration to the water table of water that has been pumped from wells for irrigation should be regarded as irrigation return rather than as recharge, unless it is pumped from one aquifer and returns to another. The return of pumped water to the ground-water reservoir from which it comes lessens the depletion due to pumping rather than adding to the total supply. Many farms in the Albuquerque area have wells which are held in reserve to supplement the surface-water supply if necessary, and a few farms depend upon wells exclusively. Lawns in Albuquerque, Bernalillo, and other urban areas, and many small orchards and gardens in the area, are watered from wells. Probably something less than a third of the well water applied to the land returns to the ground-water reservoir and reduces proportionately the depletion due to pumping from wells.

Discharge from the Ground-Water Reservoir

In the Albuquerque area, a part of the ground water is discharged from the ground-water reservoir through springs and seeps, a part is discharged through drains, a part is discharged by means of evapotranspiration, and a part is discharged through wells. Some ground water probably seeps to the Rio Grande in the upper 4 to 6 miles at the northern limit of the study area. In general, the Rio Grande loses rather than gains water by seepage in most of the Albuquerque reach of the river. In some areas drains along each side of the river intercept ground water that might have entered the river as seepage. Over a period of years and under natural conditions, changes in storage are negligible and discharge is approximately equal to recharge. Pumping from wells and recharge from irrigation disturbed the equilibrium between natural recharge and discharge.

Springs, Seeps, and Streams

Many small springs discharge into canyons and arroyos along the face of the Sandia and Manzano Mountains. Most of these springs issue where permeable material overlies relatively impermeable material and the water table intersects the ground surface, and in those places where relatively impermeable material acts as a ground-water barrier. Some of the points of discharge are indicated by only a small damp area or seep, and perhaps by the presence of a cottonwood tree.

Some springs discharge through weathered zones in the exposed granite. Examples of such springs are those in and near the mouth of Tijeras Canyon, in the SW¼ sec. 26, T. 10 N., R. 4 E., and Embudo Spring (10.4.13.242, table 4).

Two springs in the western part of the Albuquerque area discharge at the contact between alluvial material and rocks of Cretaceous age; the springs are in arroyos on the eastern side of the Rio Puerco valley in T. 13 N., R. 1 W. Sandoval Spring is in the NE¼ sec. 16 and Alamo Spring is in the NE¼ sec. 35. Water from Alamo Spring is piped 12 miles eastward to serve stock tanks.

The average rates of discharge from different springs range from a negligible amount to about 50 gpm, and the rates of discharge of individual springs vary widely depending upon the amount of precipitation. Water discharged from the springs generally flows only a short distance before it seeps into the permeable sand and gravel.

Drains

About 100 miles of drains (pls. 1a, 1b, 2a, and 2b) have been constructed in the Albuquerque area to prevent the waterlogging of lands on the valley floor. Construction of the drains was started in 1930 and completed about 1935. The drains were excavated to depths of about 8 feet below the land surface and are maintained by the Middle Rio Grande Conservancy District.

It would be difficult to estimate the amount of water seeping into the drains because 1) parts of the drainage system are used as canals to transport diverted river water, 2) water is diverted from some drains to canals and irrigation ditches, 3) water is diverted from some drains to the Rio Grande, 4) runoff from the east mesa during and after storms is intercepted by the drains, 5) some water is pumped from the drains to irrigate lands near the drains, 6) some water is lost to evaporation and uneconomic use by vegetation growing along the drains, and 7) some water is lost from drains near the city of Albuquerque owing to a locally lowered water table.

Flow in the Albuquerque Riverside drain at the gaging station immediately below the point of inflow of the Alameda drain, in the SE¼ sec. 13, T. 10 N., R. 2 E., varies widely from year to year and from season to season; yet the flow is fairly steady and consistent over shorter periods of time (stream-gaging records on file, U. S. Geol. Survey, Surface Water Branch, Albuquerque, N. Mex.). The average fairly steady flow during November, December, January, and February of 1954-55 was 58 cfs; during the same months of 1955-56 it was 9 cfs; in 1956-57 it was 30 cfs; and in 1957-58 it was 19 cfs. The larger averages are believed to represent combined discharge of the Albuquerque Riverside drain, the Alameda drain, and the Griegos drain which enters the Alameda drain upstream. The smaller averages probably represent discharge from the Alameda and Griegos drains only, as the flow in the Albuquerque Riverside drain is diverted at times to the river at a point above the junction with the Alameda drain.

Evapotranspiration

Shallow ground water may rise to the land surface by capillarity and be evaporated, or it may be absorbed by plants and discharged into the atmosphere by transpiration. The combination of evaporation and transpiration is called "evapotranspiration." All the areas of high evapotranspiration are on the inner valley floor.

Ground water cannot rise by capillary action more than about 4 to 5 feet above the water table in sandy material, nor more than about 8 feet in fine sand, silt, and clay (Meinzer, 1923a, p. 35). Thus, if the water table is 8 feet or more below the land surface there is little loss from the zone of saturation by upward capillary movement to the land surface. Ground water is evaporated from the surface in a few relatively small swamp areas; one of the largest is in the S½ sec. 12, T. 8 N., R. 2 E., near where the Albuquerque Riverside drain empties into the Rio Grande. Water is evaporated also from a few scattered ponds that have been excavated below ground-water level along the various drains, and from the streambeds of the Rio Grande and Jemez River.

Water-loving plants that commonly extend roots into the zone of saturation, or into the moist capillary fringe above it, are called "phreatophytes." These plants use a relatively large amount of ground water where the depth to water is not more than about 10 feet. Investigations show that some phreatophytes can lift ground water from depths of 50 feet or more (Meinzer, 1923b, p. 48). Common native phreatophytes growing in the Albuquerque area include cottonwood, willow, and saltcedar; a common cultivated phreatophyte is alfalfa. A dense growth of saltcedar can use 7.2 acre-feet of water per acre per year, and a similar growth of cottonwood can use about 6 acre-feet per acre per year, according to a study of the use of water by bottom-land vegetation in the Safford Valley in Arizona (Gatewood and others, 1950, p. 203). The use of water by phreatophytes in the Albuquerque area would be somewhat less than that determined for the Safford Valley because the temperature usually is lower and the growing season shorter. The average annual temperature during 1954 at Albuquerque was 59.5° and at Safford was 65.8°F. During the same year there were 225 days between late-spring and early-fall frosts at Albuquerque and 249 days between like frosts at Safford.

About 18 square miles, or about 17 percent, of the inner valley floor is covered by dense native vegetation consisting mostly of cottonwood, willow, and saltcedar. The amount of water used by this vegetation probably is about 4 acre-feet per acre per year. Annual evapotranspiration of 4 acre-feet per acre over 18 square miles amounts to about 46,000 acre-feet per year, or the equivalent of an average annual flow of about 62 cfs. Inasmuch as the reach of the Rio Grande within the project area is about 40 miles, the estimated average annual loss by evapotranspiration is about 1,150 acre-feet, or 1.6 cfs, per mile of the valley.

Some areas of saltcedar are developing in the part of the Jemez River valley within the project area. This potential source of evapotranspiration may increase the quantity of ground water consumed by natural vegetation in the area as much as 15 percent. Early control or eradication of this growth would prevent large future evapotranspiration losses.

Consumptive Use of Water in the Albuquerque Area

The amount of water consumed varies widely with type of use. It is estimated that roughly a third of the water pumped from public-supply wells is consumed. Slightly more than half the water used by installations served by Albuquerque sewers is discharged as effluent at the sewage-disposal plant. This pumpage includes all water from both municipally owned and privately owned wells and about a fourth of the water from industrial wells. About 41,000 acre-feet was pumped during 1958, of which 33,600 acre-feet was pumped by the city, 5,600 was pumped by private owners for public supply, and 1,800 acre-feet was pumped by industries served by city sewers. During the same year 23,500 acre-feet -- 57 percent of the water pumped -- was discharged at the sewage-disposal plant; the remaining 43 percent, or 17,500 acre-feet, was either consumed by evaporation or transpiration or returned to the ground-water reservoir. Most of the water was used to support vegetation and a part of it reached, or will reach, the ground-water reservoir. The consumption of water pumped for industrial use ranges from about 50 percent to almost nothing. It is estimated that about 70 percent of the water pumped for irrigation is consumed, and about 30 percent returns to the ground-water reservoir.

QUALITY OF WATER

The ground and surface water in the Albuquerque area is of suitable chemical quality for most uses; however, a few wells yield water unsuitable for some purposes, and water in streams contains suspended sediments which must be removed to make it suitable for domestic and industrial use. Chemical analyses of 95 ground-water samples are given in table 6; and analyses of 11 surface-water samples, collected from drains and streams, are given in table 7. The significance and effects of the most common dissolved mineral constituents and properties in water are given in table 8.

The chemical quality of water changes from the time the water falls on the surface of the ground as rain, hail, or snow. Rainwater contains some gases, dissolved from the atmosphere, and dust particles. As the water seeps through the soil and rocks it dissolves many substances. The type and amount of materials dissolved by water depend on the kind and amount of dissolved materials present in the water when it enters the ground, on the type of rock materials with which the water comes in contact, and on the duration of contact. The most common chemically active substances usually present in water are oxygen, carbon dioxide, and organic acids. These substances react readily with materials that are commonly found in the soil and rocks. Other conditions that can increase the concentration of dissolved material in ground water are evapotranspiration and the addition of sewage and industrial waste.

Principal Dissolved Mineral Constituents

The principal dissolved mineral constituents in most natural waters are silica, calcium, magnesium, sodium, bicarbonate, sulfate, and chloride. Iron, potassium, carbonate, nitrate, fluoride, and boron are minor constituents in most ground water. The ions of iron, calcium, magnesium, sodium, and potassium are called "cations" and sometimes are referred to as "bases" or "basic ions." The ions of bicarbonate and carbonate, sulfate, chloride, nitrate, and fluoride are called "anions" and are sometimes referred to as "acids" or "acidic ions."

The analyses given in tables 6 and 7 and shown in part in plates 3a and 3b are of the dissolved constituents that are most commonly present in water. Each of the constituents imparts certain characteristics to the solution and affects the suitability of water for various uses (table 8).

Specific conductance is a measure of the capacity of a sample of water to conduct an electric current; it varies with the concentration and the degree of ionization of the substances in solution (the degree to which the molecules dissociate) and with the temperature of the water. Specific conductance indicates the approximate total concentration of chemical constituents in water. It is more easily determined than the concentration of dissolved solids in chemical analysis; therefore, it is frequently used as a guide to the suitability of water for various uses. In the Albuquerque area the ratio of the dissolved-solids content, in parts per million, to the specific conductance, in micromhos per centimeter, ranges from 0.6 to 1.0 and averages 0.7.

A convenient classification to indicate the freshness or salinity of water is adapted from a table used to define salinity of water in the United States (Krieger, Hatchett, and Poole, 1957, p. 5).

Of the 95 samples of water collected in the Albuquerque area for this study, assuming that the dissolved-solids content is 0.7 of the specific conductance, 82 of the samples would be classified as fresh water, 10 as slightly saline, 2 as moderately saline, and 1 as very saline (table 6). The terms are used as defined in the following table:

Classification of Water with Respect to Salinity

	Dissolved solids (ppm)
Fresh	Less than 1,000
Slightly saline	1,000 - 3,000
Moderately saline	3,000 - 10,000
Very saline	10,000 - 35,000
Brine	More than 35,000

Water in Pre-Tertiary Rocks

The quality of water in rocks of pre-Tertiary age ranges from unsuitable to suitable for most uses. Water in rocks of this age in the Sandia and Manzano Mountains generally is low in dissolved solids.

Water in rocks of this age in the Rio Puerco valley probably is moderately saline. The presence of gypsum disseminated through the Mancos shale and Mesaverde group would tend to make the water high in sulfate content. Although no analyses were made of water from wells completed in rocks of pre-Tertiary age in the Rio Puerco valley, the water from well 12.1W.8.132 (table 4) is reported to be of poor quality and very corrosive.

Water in the Santa Fe Group

The Santa Fe group is the largest and most productive aquifer in the Albuquerque area and it yields water of good quality in most places. It is the principal source of supply for public and industrial use.

Of the 68 water samples collected from wells tapping the Santa Fe group, 61 are classified as fresh, 6 as slightly saline, and 1 as moderately saline. Samples collected from wells on the east mesa were all fresh. Samples collected from wells in the inner valley were fresh with one exception (13.4.1.243, tables 2 and 6), although several samples collected from wells north of Bernalillo were near the upper limit for fresh water. Samples collected on the west mesa east of the ground-water trough were fresh with one exception (11.2.22.441, tables 4 and 6). Samples from west of the ground-water trough were largely fresh, but there were several exceptions.

The source and general type of rock materials in the valley fill vary from place to place, and this results in variations in the chemical quality of water in the aquifer. For example, the sediments underlying the east mesa are derived largely from the hard rocks of Precambrian and Paleozoic age composing the Sandia and Manzano Mountains; and, as these rocks contain a relatively small amount of readily soluble materials, the water in contact with them usually is fresh. On the other hand, some of the sediments underlying the west mesa, especially west of the ground-water trough, are derived from rocks of Mesozoic age that contain a relatively large amount of readily soluble materials, and water in contact with these rocks may be

PLATE 3b

Map showing chemical quality of water in the northern half of the Albuquerque area, Sandoval County, New Mexico.

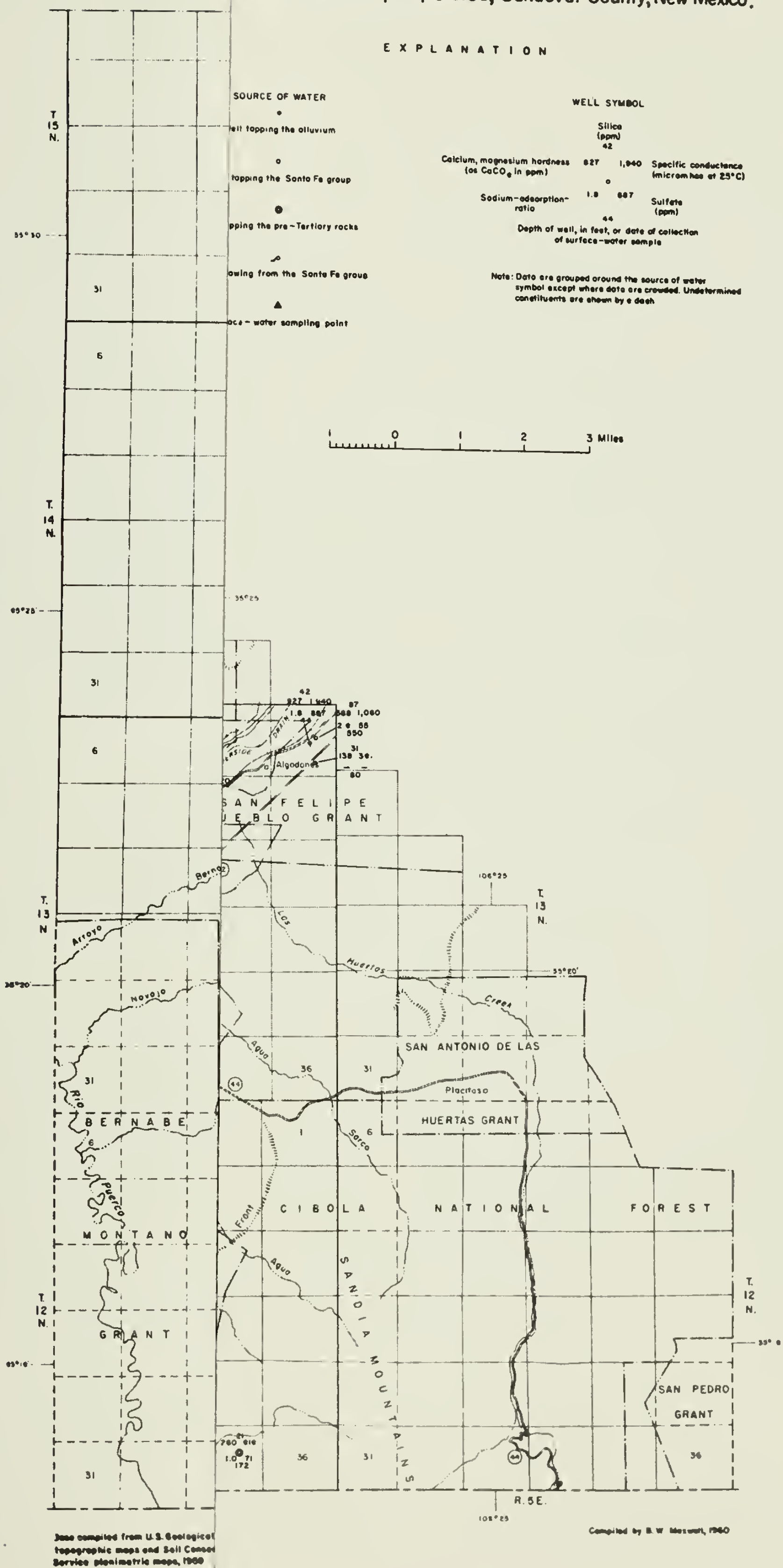
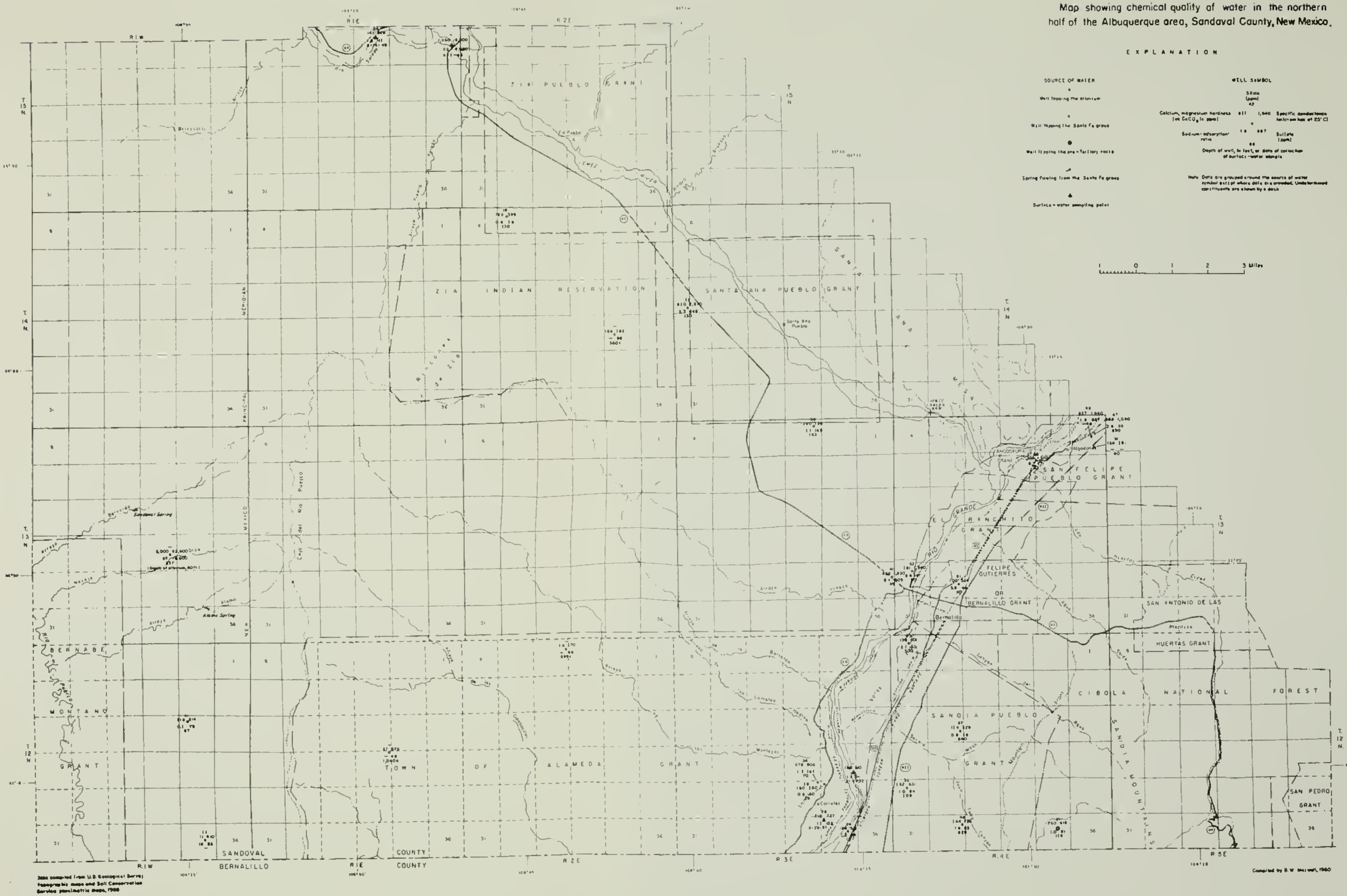


PLATE 3b

Map showing chemical quality of water in the northern half of the Albuquerque area, Sandaval County, New Mexico.



expected to contain relatively large amounts of dissolved minerals. A relatively high concentration of dissolved minerals in the water of the Santa Fe group and alluvium north of Bernalillo may be related to volcanic activity and faulting. The high silica content of water from wells 13.4.1.234, 243, and 412 and 13.4.29.421 (tables 2 and 6) suggests that hydrothermal solutions are mixing with the ground water. A slight increase in dissolved solids in the ground water beneath downtown Albuquerque, as indicated in plates 3a and 3b, may be attributed to induced recharge from the overlying alluvium because of heavy pumping from wells tapping the Santa Fe group. Sources and amounts of recharge affect the chemical quality of water. Stock wells on the west mesa that tap only the upper part of the saturated zone in the aquifer, such as well 10.1.18.331 (tables 4 and 6), yield better water than deeper industrial wells in the same area, such as well 10.1.30.220 (tables 2 and 6) -- probably because of local recharge from the surface. The stock wells in Tps. 11 and 12 N., Rs. 1 W. and 1 and 2 E., yield some of the least mineralized water in the area (pls. 3a and 3b), probably because the area is higher and receives more rainfall, 10 to 14 inches annually (Dortignac, 1956, fig. 3), than most of the area. Recharge from streams whose water is slightly or moderately saline, such as the Rio Puerco and the Jemez River, affects the quality of water in some wells. Thus the slightly saline water sampled from well 14.3.18.340 (tables 4 and 6) is attributed to seepage from the Jemez River, and the relatively high mineral content of water from wells 9.1W.4.424 and 8.2W.24.131 (tables 4 and 6) is attributed to recharge from the Rio Puerco.

Water in the Alluvium

The water in the alluvium usually is more mineralized than water in the underlying Santa Fe group, although the two aquifers are hydraulically connected. The concentration of minerals in, and the suitability of the water sampled for irrigation from, the two formations are shown in figures 12 and 13.

The concentration of dissolved mineral constituents in water in the alluvium usually varies inversely with depth below the land surface. Near the contact between the alluvium and the Santa Fe group, the chemical quality of the waters in the two formations is similar because the water can move from one formation to the other. Near the land surface the water usually is more highly mineralized because of evapotranspiration. According to drillers, the water of the best chemical quality usually is obtained from wells more than 80 feet deep, water of intermediate quality is from wells 40 to 80 feet deep, and water of poorest quality is from wells less than 40 feet deep. However, the water from most of the shallow wells still qualifies as being fresh (contains less than 1,000 ppm of dissolved solids).

The very saline water sampled from well 13.1W.22.421 (tables 4 and 6) was pumped from alluvium derived from the Mancos shale and the Mesaverde group of Cretaceous age. These formations consist largely of shale and sandstone which contain considerable gypsum and other soluble minerals. Consequently, ground water contained in these formations, or in alluvium derived from them, usually contains a relatively large amount of dissolved minerals.

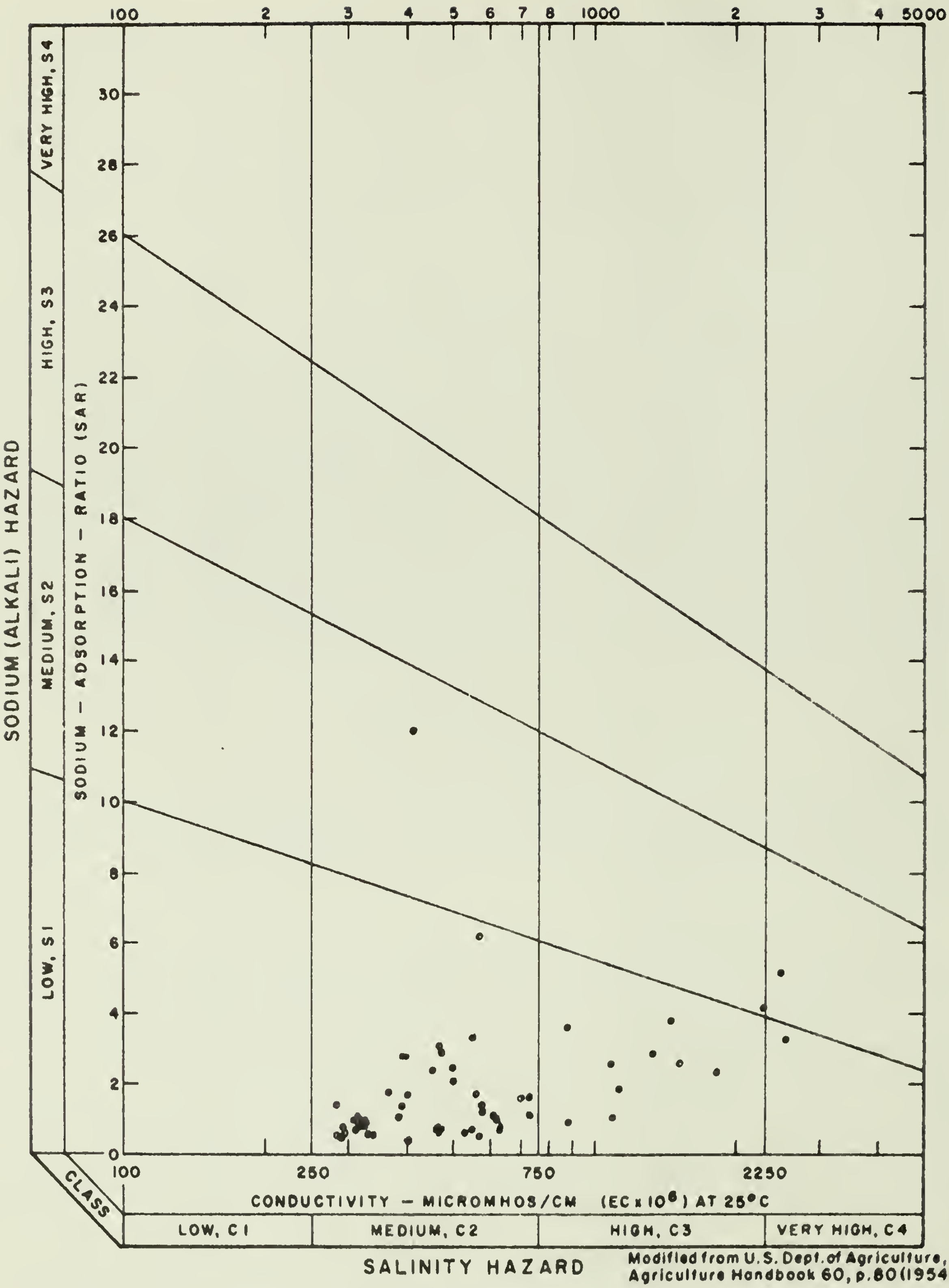


FIGURE 12. -- Suitability of water in the Santa Fe group for irrigation.

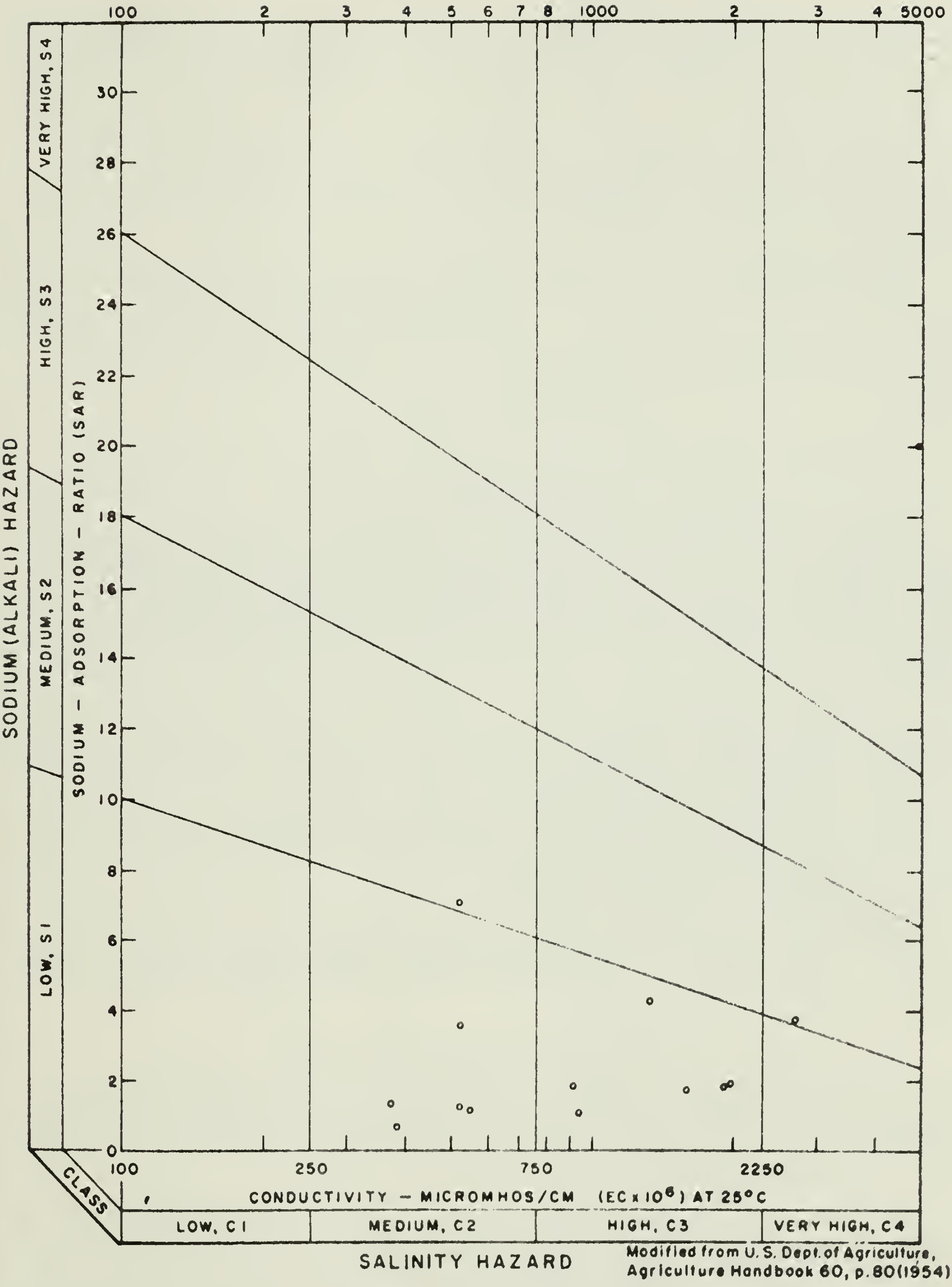


FIGURE 13. -- Suitability of water in the alluvium for irrigation.

The chemical quality of the shallow water in the alluvium has improved greatly since 1930 when the Middle Rio Grande Conservancy District began the construction of drains. Waterlogged fields and the formation of alkali on the land surface was a common condition on the inner valley floor prior to that time (Bloodgood, 1930, p. 26-27), and it can be inferred that the shallow ground water was saline to some degree. Since the drains were constructed the water table has been lowered, and most of the accumulated minerals that had been concentrated at the land surface by evaporation and transpiration have been leached from the soil.

Shallow water not only is more mineralized but is more likely to contain iron which may be deposited by iron-precipitating bacteria; it also is more likely to be corrosive. Several owners of shallow wells have reported that their wells produced water that clogged the pipes in their houses and corroded the well casing to such an extent that they had to be replaced.

Surface Water

Surface water in the Albuquerque area generally is of good chemical quality but contains objectionable quantities of suspended sediment, according to data listed by Scofield (1938) and by the U. S. Geological Survey (1955). Surface water is used only for irrigation because ground water is readily available for other uses and generally does not require treatment.

Most of the water in the drains is derived from ground water; however, surplus irrigation water usually is wasted into the drains, and some drains are used to transport irrigation water. Thus, the quality of the water in the drains depends in part on which area is drained and on the amount of irrigation water added to the drain. Drain water usually is more mineralized than river water (table 7) because it has been concentrated by evapotranspiration during use for irrigation.

The chemical quality of water in the Rio Grande generally is satisfactory for most purposes. The specific conductance ranges from about 200 micromhos at high flow to about 600 micromhos at low flow; the sediment content, however, is always high.

Water in the Rio Puerco and the Jemez River is more mineralized than water in the Rio Grande. Samples collected by the Geological Survey from the Rio Puerco at the State Highway 6 crossing 6 miles south of the area indicate a range in specific conductance from 1,700 micromhos at high flow to 6,100 micromhos at low flow.

The conductance of water samples collected daily during 1955-58 by the Geological Survey for suspended-sediment analysis from the Jemez River below Jemez Canyon Dam ranged from slightly less than 400 to more than 4,000 micromhos. Low conductance occurs during high flow and high conductance during low flow. The Rio Salado, which flows into the Jemez at San Ysidro, usually is highly mineralized; the water often has a conductance of more than 10,000 micromhos, but immediately after rains the water may have a conductance of less than 1,000 micromhos. Water moves from these streams into the ground-water reservoir in areas south of the Jemez River in Sandoval County and east of the Rio Puerco in Bernalillo County. This movement results in zones of slightly to moderately saline ground water.

Floodwaters in the arroyos contain much suspended sediment but are low in dissolved solids. Samples of water from Bear Arroyo at State Highway 422 (11.3.26.443) and of water from Embudo Arroyo at State Highway 422 (10.3.9.234, table 7) are typical of floodwaters in most arroyos. Snowmelt and storm runoff in all the streams usually is of good chemical quality because the water has not been in contact with the rocks long enough to dissolve much mineral matter.

Temperature of Ground Water

The temperature of water discharged from wells in the Albuquerque area ranges from 51° to 90°F, although most of the temperatures were between 57° and 71°F. The average of the 122 temperatures listed in tables 1, 2, 3, and 4 is 64°F. The temperatures measured at 75 wells tapping the Santa Fe group ranged from 54° to 90° and averaged 66°F. Temperatures at 31 wells tapping the alluvium ranged from 51° to 70° and averaged 61°F. The average temperature at 16 wells for which it is uncertain whether the aquifer is the Santa Fe, the alluvium, or both, was 59°F. The low temperatures of 51°F in well 12.3.35.243 (tables 4 and 6), tapping the alluvium, and 54°F in well 13.4.30.231 (tables 4 and 6), tapping the Santa Fe group, are attributed to recharge of cold water from the nearby Rio Grande. The temperatures above 70°F were of water from relatively deep wells tapping the Santa Fe group. Most of these wells were within three areas: 1) on the east mesa in the general vicinity of secs. 16, 20, and 29, T. 10 N., R. 4 E.; 2) on the inner valley floor south of Albuquerque in the general vicinity of secs. 8 and 9, T. 9 N., R. 3 E., and sec. 32, T. 10 N., R. 3 E.; and 3) on the west mesa where unusually warm water exists in the Santa Fe in the vicinity of well 10.2.21.343 (table 1); here the temperature of the pumped water is 90°F, which is the highest observed in the Albuquerque area. The cause of the relatively high ground-water temperatures is not known but may be volcanism or faulting.

Records of Wells and Springs

Records of 415 wells and 3 springs were obtained. The locations of these are shown in plates 2a and 2b. The wells are separated into groups on the basis of the use of water and the available pertinent data are given in tables 1, 2, 3, and 4. The springs are included in table 4. It was not possible to obtain measurements of the well depth or of the water level in some of the wells, and the data given in the table for these wells were reported by well owners, tenants, employees, or drillers. In table 4 the wells in ranges west of the principal meridian are presented first, and wells and springs in ranges east of the principal meridian follow.

CONCLUSIONS

Ground water in sufficient quantities for municipal, industrial, irrigation, and other uses is available in the valley fill, comprising the Santa Fe group of Tertiary and Quaternary age and the alluvial deposits of Quaternary age. Wells that yield more than 200 gpm can be developed almost everywhere in the valley fill, and wells that yield more than 2,000 gpm can be developed in many places in these deposits. The total thickness of the valley fill is not known, but a few oil-test holes indicate that it is more than 6,000 feet.

The Santa Fe group and the alluvium yield water of acceptable quality for most purposes. The specific conductance of water in the Santa Fe group ranges from 283 to 5,290 micromhos. Most of the water, however, has a conductance of less than 1,000 micromhos. The specific conductance of water in the alluvium ranges from 361 to 22,600 micromhos; however, only one well yields water having a conductance of more than 5,000, and most wells in the alluvium yield water having a conductance of less than 2,000. In the allrvium beneath the valley floor water of poorer quality is found at shallow depth. This water is mostly that added to the ground-water reservoir from irrigation return. With increased depth the quality of water is better and approaches the quality of water present in the underlying and adjacent rocks of the Santa Fe group. Little is known regarding the quality of water in the Santa Fe group at depths greater than are reached by existing water wells, but it is believed to be good, especially beneath the east mesa. The approximate thickness of the valley fill, the availability of water at depths greater than those of presently used wells, and the quality of water at depth could be determined by drilling a deep test hole near the center of the valley.

Pumpage of ground water by the city of Albuquerque increased steadily from 2 mgd in 1930 to about 34 mgd in 1959. If the use of water continues to increase at the rates of recent years, the average daily pumpage will be about 45 million gallons in 1965 and 55 million gallons in 1970. The per capita demand for water in Albuquerque in 1959, estimated on the basis of a population of 200,000 and the pumpage from municipal wells, wells not municipally owned, and industrial wells within the city was at least 200 gpd per person.

The water table slopes, and ground water moves, southwestward from the Sandia-Manzano mountain front and southeastward from the Rio Puerco, toward a ground-water depression, or trough, about 8 miles west of and roughly parallel to the Rio Grande. The water table in the Rio Grande's inner valley slopes southward and resembles in cross section a horizontal shelf on the southwestward slope. The cause of the ground-water trough is not known. The Santa Fe group may be thickest under the trough; the permeability of the Santa Fe may be greatest along the axis of the trough; and recharge may be larger east and west of the trough than in the area overlying the trough; or the trough may be the result of the presence of a thicker section of saturated materials of ordinary permeability.

Water levels in wells in the area fluctuate from season to season and from year to year. Long-term changes in water level have been observed in the vicinity of downtown Albuquerque, where water levels have declined as much as 20 feet during the past 10 to 20 years. It is expected that this depression in the water table, as well as other smaller depressions in the vicinity of heavily pumped wells, will continue to develop and that new depressions in the water table will develop around the newly constructed well fields on the east mesa, especially around the wells near the Sandia and Manzano mountain fronts.

The ground-water reservoir in the area is recharged from precipitation, from perennial and ephemeral streams, from irrigation systems, and from water applied to the land. Considerable recharge occurs near the top of alluvial fans near the mouths of many canyons in the Sandia and Manzano Mountains. Additional recharge from drains and the river will be induced in the inner valley as the ground-water depression beneath downtown Albuquerque develops and spreads to include an area larger than that presently being drained. When the ground-water depression spreads to bosque areas, some water now being used by cottonwoods, willows, and saltcedars will be salvaged for beneficial use. Additional water could be salvaged by elimination or control of saltcedar, cottonwood, and willow.

Ground water and surface water are interrelated in the Rio Grande valley. Pumping from wells affects streamflow -- water which eventually would have reached the Rio Grande is diverted at the well. Only a part of water so diverted will eventually reach the river.

As pumping continues and increases, more water will be prevented from reaching the river; and, as pumping continues and the water levels near the river and the drainage canals are lowered, a larger quantity of water will be diverted from the river and the drainage canals into the ground-water reservoir. This water will then be pumped from wells.

No significant amount of water can be developed from rocks of pre-Tertiary age because of the low yields from wells in these rocks.

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TABLES

TABLE 1

RECORDS OF MUNICIPALLY OWNED WELLS IN THE ALBUQUERQUE AREA, BERNALILLO AND SANDOVAL COUNTIES, N. MEX.

Location number: Designates well and its location. (See well-numbering system.)
Altitudes of wells are estimated from topographic maps; altitudes above sea level (ft).
Type of well: All wells listed are drilled unless otherwise noted in remarks.
Depth of well and water level: Measured depths are given in tenths of a foot; reported depths are given in feet.
Principal water-bearing bed: Gravel and sand in the alluvium of Quaternary age, Qal; and the Santa Fe group of Tertiary and Quaternary age, QTs.
Yield and drawdown: M, measured; R, reported.
Use of water: P, public supply; O, observation; N, none.
Method of lift: T, turbine pump; N, no pump; E, electric.
Last two wells are owned by the Town of Bernalillo; all others by the City of Albuquerque.

Location	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diam. of well (in.)	Principal water-bearing bed	Water level: Below lsd	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above lsd	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Remarks
10. 2. 1.431	Roscoe Moss Co.	1958	Valley floor	4965	813	16	QTs	21.77	10- 1-58	Top of measuring pipe	0	2090M	1958	65M	9	P	T,E	-	Well 2, Duranes field. Located 0.3 mi. W of Rio Grande Blvd. and Matthew Ave. NW. Recovery test indicated transmissibility about 32,000 gpd/ft.
12.121	do.	1953	do.	4962	950	18-12	QTs	4	1953	-	-	3360R	1953	151R	30	P	T,E	-	Well 7, Duranes field. Located about 300 ft S of Beach Rd. SW, and 0.2 mi W of Gabaldon Dr. NW.
12.222	do.	1953	do.	4963	950	18	QTs	12	1953	-	-	1700R	1953	202R	71	P	T,E	-	Well 6, Duranes field. Located about 50 ft S of Los Anayas Rd. NW, and 20 ft W of Duranes ditch.
12.223	H. Sheets	1953	do.	4962	-	6	Qal,QTs	20.50	8- 1-57	Top of casing	6.0	-	-	-	-	O	N	-	Located in yards of Duranes pumping station. About 400 ft N of Zickert Rd. NW, and 30 ft E of Apple Lane NW. Equipped with recording gage.
12.312	Roscoe Moss Co.	1953	do.	4958	950	18-12	QTs	4	1953	-	-	2650R	1953	133R	179	P	T,E	-	Well 4, Duranes field. Located at dead end of Duranes Rd. NW, about 0.2 mi. W of Gabaldon Dr. NW.
12.412	do.	1953	do.	4958	1,000	18-12	QTs	10	1953	-	-	2800R	1953	105R	127	P	T,E	70	Well 3. Duranes field. Located about 400 ft S of Duranes Rd. NW, near junction of Los Luceros Rd. NW. Well cased to 950 ft. See analysis.
13.112	do.	1953	do.	4955	950	18-12	QTs	4	1953	-	-	2200R	1953	202R	129	P	T,E	-	Well 5. Duranes field. Located about 0.15 mi. N of junction of Mountain Rd. NW. and Gabaldon Dr. NW. and 0.15 mi. W of Gabaldon Dr. NW.
14.321	-	-	West mesa	5098	184	11	QTs	152.8	11-27-56	Top of casing	0	400R	-	-	-	N	N	-	Lavaland well 1. Well is SE of Fortuna Rd. and 57th St. NW.
21.343	Roscoe Moss Co.	1960	do.	5175	1,180	16	QTs	255.55	1-13-59	do.	2.0	-	-	-	-	P	T,E	90	Well 1. West Mesa field. Located about 300 ft N of Central Ave. near junction with Bridge Blvd. Contractor had difficulty developing well owing to sand in pumped water. Highest ground-water temperature observed in area.
23.121	do.	1953	Valley floor	4963	500	18	QTs	12	1953	-	-	1900R	1953	225R	55	P	T,E	-	Well 13. Atrisco field. Located at dead end of Ute Dr. NW, about 100 ft E of Arenal Main Canal.
24.112	-	1952	do.	4953	504	-	QTs	-	-	-	-	750R	-	-	-	P	T,E	-	Well 9, Atrisco field. Located about 100 ft E of dead end of Rincon Rd. SW.
24.112a	Roscoe Moss Co.	1958	do.	4953	813	16	QTs	10.38	11-17-58	Top of measuring pipe	.5	1000M	11-15-58	46M	5	P	T,E	64	Well 9. Atrisco field. Located about 0.2 mi. N of Central Ave. about 0.4 mi. W of Old Town Bridge. Replacement of existing well 80 ft E. Much sand was pumped during development. Test indicated transmissibility about 60,000.
24.133	-	1954	do.	4946	336	14	QTs	-	-	-	-	750R	-	-	-	P	T,E	62	Well 12, Atrisco field. Located about 100 ft S of Osage St. SW, and 50 ft W of Osage Pl. SW. See analysis.
24.234	-	1952	do.	4947	430	14	QTs	-	-	-	-	750R	-	-	-	P	T,E	-	Well 11. Atrisco field. Located about 50 ft S of Stella Rd. SW, and 150 ft W of Sunset Rd. SW.
24.313	-	1950	do.	4948	558	14	QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 1, Atrisco field. Located in yards of Atrisco pumping station about 100 ft S of Gonzales Rd. SW, and 50 ft E of Isleta Drain.
24.332	-	1950	do.	4946	368	14	QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 3. Atrisco field. Located about 100 ft N of Gonzales Rd. SW, and 30 ft W of Atrisco Ditch.
24.333	-	1951	do.	4943	412	14	QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 8, Atrisco field. Located about 1,200 ft S of Sunset Gardens Rd. SW, and 75 ft W of Isleta Drain.
24.343	-	1952	do.	4945	257	-	QTs	-	-	-	-	750R	-	-	-	P	T,E	-	Well 10, Atrisco field. Located about 300 ft S of Sunset Gardens Rd. SW, and 50 ft E of Atrisco Ditch. Well cased to 205 ft

TABLE 1 (continued)

Location	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diam. of well (in.)	Principal water-bearing bed	Water level: Below lsd	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above lsd	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Remarks
10. 2.24.413	H. Sheets	1953	Valley floor	4945	-	6	Qal,QTs	21.30	8- 1-57	Top of casing	5.5	-	-	-	-	O	N	-	Located about 30 ft S of Gonzales Rd. SW, and 10 ft E of Mae Ave. SW. Equipped with recording gage.
24.413a	-	1950	do.	4946	365	14	QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 4, Atrisco field. Located about 300 ft S of Mae Ave. SW, and 30 ft E of Atrisco Ditch.
24.432	-	1950	do.	4944	438	14	QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 2, Atrisco field. Located about 50 ft N of Sunset Gardens Rd. SW, and 30 ft E of Arenal Ditch.
25.111	-	1951	do.	4947	396	14	QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 5, Atrisco field. Located in yards of Atrisco 2 pumping station at dead end road about 600 ft W of Atrisco Dr. SW, and 50 ft E of Isleta Drain.
25.211	-	1951	do.	4945	360	14	QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 7. Atrisco field. Located about 20 ft S of Zocaria Ave. SW, and 30 ft W of Arenal Ditch.
25.213	-	1951	do.	4944	360	14	QTs	-	-	-	-	1000R	-	-	-	P	T,E	66	Well 6. Atrisco field. Located about 150 ft N of Five Points Rd. SW, and 20 ft E of Arenal Ditch. See analysis.
10. 3. 1.244	Roscoe Moss Co.	1960	East mesa	5287	1020	16	QTs	386.38	1-15-60	Top of casing	1.0	2200M	1-13-60	29.5M	5	P	T,E	65	Well 2, Lyendecker field. Located about 100 ft W of Louisiana Blvd. and 0.1 mi. W of Comanche Rd. NE. Recovery test indicated transmissibility about 400,000.
4.331	H. Sheets	1948	Valley floor	4972	268	13	QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 2, Candelaria field. Located about 500 ft N of Candelaria Rd. NE, and 100 ft E of Commercial St. NE. Well cased to 272 ft.
4.332	do.	1948	do.	4978	310	14	QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 3, Candelaria field. Located about 500 ft N of Candelaria Rd. NE, and 100 ft W of Edith St.NE.
4.333	do.	1948	do.	4974	578	14	QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 1, Candelaria field. Located in yards of Candelaria pumping station about 80 ft N of Candelaria Rd. NE, and 150 ft W of Arno St. NE.
5.444	do.	1948	do.	4970	296	14	QTs	-	-	-	-	1000R	-	-	-	P	T,E	60	Well 4, Candelaria field. Located about 30 ft S of Candelaria Rd. NE, and 40 ft W of A.T.&S.F.RR tracks. See analysis.
6.121	Roscoe Moss Co.	1955	do.	4967	820	-	QTs	12	1955	-	-	2400R	1955	62R	-	P	T,E	-	Well 2, Griegos field. Located about 200 ft N of Cherokee Rd. NW, and 100 ft E of Haskell Rd. NW.
7.141	do.	1960	do.	4960	1000	16	QTs	22.08	4- 4-60	Top of casing	2.5	2010M	3-25-60	63M	5	P	T,E	-	Well 1, Duranes field. Located 60 ft N of Indian School Rd. and 150 ft E of Griegos Drain. Recovery test indicated transmissibility about 75,000.
8.243	H. Sheets	1941	do.	4975	375	13	QTs	-	-	-	-	750R	-	-	-	P	T,E	68	Well 11, Main Plant field. Located E of A.T.&S.F. RR tracks about 300 ft S of Menaul Blvd.NE, and 100 ft W of Commercial St. NE. Well cased to 370 ft. See analysis.
8.421	do.	1946	do.	4970	168	-	Qal,QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 14, Main Plant field. Located E of A.T.&S.F. RR tracks about 100 ft E of intersection of Commercial St. NE, and Cutler Ave. NE. Well cased to 166 ft.
8.423	do.	1941	do.	4968	356	13	Qal,QTs	-	-	-	-	650R	-	-	-	P	T,E	-	Well 12, Main Plant field. Located about 300 ft W of intersection of Broadway NE, and Euclid Ave. NE, and 150 ft E of Commercial St. NE. Well cased to 354 ft.
8.424	do.	1939	do.	4971	293	13	QTs	-	-	-	-	250R	-	-	-	P	T,E	-	Well 9. Main Plant field. Located about 30 ft W of intersection of Broadway NE. and Euclid Ave. NE. Well cased to [illegible] ft.
8.431	do.	1948	do.	4964	453	13-12	QTs	-	-	-	-	850R	-	-	-	P	T,E	-	Well 15, Main Plant field. Located in Coronado Park about 80 ft S of Indian School Rd. NW, and 150 ft E of 4th St. NW. Well cased to 447 ft.
8.431a	do.	1948	do.	4962	598	14	QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 19, Main Plant field. Located in Coronado Park about 30 ft N of McKnight Ave. NW, and 150 ft E of 4th St. NW.
8.431b	do.	1948	do.	4963	142	-	Qal,QTs	-	-	-	-	500R	-	-	-	P	T,E	-	Well 20, Main Plant field. Located in Coronado Park about 40 ft W of 2nd St. NW, and 200 ft N of McKnight Ave. NW.
8.441	do.	1946	do.	4967	180	-	Qal,QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 13, Main Plant field. Located about 15 ft N of Indian School Rd. NE, and 40 ft E of A.T.&S.F. RR tracks.
8.443a	do.	1947	do.	4965	351	-	QTs	-	-	-	-	1000R	-	-	-	P	T,E	69	Well 18, Main Plant field. Located about 40 ft E of Commercial St. NE. and 30 ft S of McKnight Ave. NE. See analysis.
9.311	do.	1940	do.	4993	403	13	QTs	-	-	-	-	750R	-	-	-	P	T,E	-	Well 10. Main Plant field. Located about 300 ft W of Edith Blvd. NE. and 30 ft N of Prospect Ave. NE. Well cased to 344 ft.
9.312	do.	1945	do.	4983	378	13-13	QTs	-	-	-	-	800R	-	-	-	P	T,E	-	Well 17, Main Plant field. Located about 50 ft S of Cutler Ave. NE. and 35 ft W of Alameda lateral. Well cased to 360 ft.

TABLE 1 (continued)

Location	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diam. of well (in.)	Principal water-bearing bed	Water level: Below lsd	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above lsd	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Remarks
10.3.11.143	-	-	East mesa	5176	402.0	10	QTs	218.68	8- 2-57	Bottom of steel rail	1.0	-	-	-	-	P,O	T,E	-	Well 3, Bel Air field. Located about 100 ft W of Menaul Blvd. NE, and 100 ft E of Graceland Dr. NE.
11.244	-	1950	do.	5212	376	16-12	QTs	-	-	-	-	-	-	-	-	P	T,E	63	Well 1, Bel Air field. Located in yards of Bel Air pumping station about 200 ft N of Menaul Blvd. NE, and 100 ft W of San Mateo Blvd. NE. See analysis.
11.244a	-	1950	do.	5212	400	16-13	QTs	-	-	-	-	-	-	-	-	P	T,E	-	Well 2, Bel Air field. Located in yards of Bel Air pumping station about 300 ft E of Menaul Blvd. NE, and 100 ft W of San Mateo Blvd. NE.
17.143	J. Wolking	1932	Valley floor	4958	550	13	QTs	-	-	-	-	1000R	-	-	-	P	T,E	-	Well 3, Main Plant field. Located in Wells Park about 100 ft N of Mountain Rd. NW, and 50 ft W of 5th St. NW.
17.232	H. Sheets	1953	do.	4960	152.5	6	Qal,QTs	29.40	8- 1-57	Top of casing	5.5	-	-	-	-	O	N	-	Located at dead end of Summer Ave. NW, about 200 ft E of 1st St. NW. Equipped with recording gage.
17.241	do.	1939	do.	4958	300	13	QTs	13	1939	-	-	650R	-	-	-	P	T,E	-	Well 7, Main Plant field. Located about 300 ft N of Kinley Ave. NE, and 200 ft E of Broadway NE. Well cased to 287 ft.
17.242	do.	1938	do.	4968	185	13	Qal,QTs	20	-	-	-	867R	-	45R	-	P	T,E	-	Well 6, Main Plant field. Located about 50 ft S of Kinley Ave. NE, and 50 ft W of Edith Blvd. NE. Well cased to 180 ft.
17.244	do.	1942	do.	4968	374	13	QTs	-	-	-	-	850R	-	-	-	P	T,E	-	Well 13, Main Plant field. Located about 150 ft S of Kinley Ave. NE, and 80 ft W of Edith Blvd. NE. Well cased to 369 ft.
17.411	J. Turner	1936	do.	4955	98	-	Qal	-	-	-	-	450R	-	-	-	P	T,E	-	Well 5, Main Plant field. Located in city equipment yards about 150 ft S of Mountain Rd. NE, and 50 ft W of Broadway NE.
17.412	J. Wolking	1932	do.	4953	423	13	QTs	-	-	-	-	640R	-	56R	-	P	T,E	-	Well 1, Main Plant field. Located in city equipment yards about 400 ft E of Mountain Rd. NE, and 600 ft W of Broadway NE.
17.412a	do.	1932	do.	4953	442	13	QTs	-	-	-	-	1016R	-	66R	-	P	T,E	-	Well 2, Main Plant field. Located in city equipment yards about 100 ft S and 200 ft W of intersection of Broadway NE, and Granite Ave. NE.
17.412b	do.	1932	do.	4957	65	-	Qal	-	-	-	-	350R	-	-	-	P	T,E	-	Well 3A, Main Plant field. Located in city equipment yards about 300 ft S of Mountain Rd. NE, and 400 ft W of Broadway NE.
17.414	J. Turner	1936	do.	4957	65	13	Qal	-	-	-	-	600R	-	-	-	P	T,E	-	Well 2A, Main Plant field. Located in city equipment yards about 600 ft S of Mountain Rd. NE, and 400 ft W of Broadway NE.
20.214	-	-	do.	4956	32	192	Qal	24.6	10-3-56	Top of concrete landing	-9.0	1000R	-	-	-	In,O	T,E	-	Battery of 9 dug wells. Originally municipal supply well. Now used to drain city lines. Well is E of city pumping plant at Tijeras Ave. and Broadway Blvd. NE.
20.214a	H. Sheets	1942	do.	4960	96	-	Qal	-	-	-	-	500R	-	-	-	P	T,E	-	Well 1A, Main Plant field. Located in yards of main pumping station about 100 ft S of Tijeras Ave. NE, and 200 ft W of Broadway NE.
20.214b	J. Wolking	1932	do.	4959	714	13	QTs	-	-	-	-	1030R	-	74R	-	P	T,E	-	Well 4, Main Plant field. Located about 100 ft S of Tijeras Ave. NE, and 50 ft W of Broadway NE.
27.343	Roscoe Moss Co.	1955	East mesa	5313	1000	16-14	QTs	568	1955	-	-	1250R	1955	46R	-	P	T,E	69	Well 1, Burton reservoir. Located in Burton Park about 75 ft S and 150 ft W of intersection of San Rafael Ave. SE, and Amherst Ave. SE. See analysis.
30.443	do.	1960	Westward slope to valley	4993	1000	16	QTs	68.67	3-19-60	Top of casing	1.0	1890M	2-18-60	98M	5	P	T,E	79	Well 7, San Jose field. Located 35 ft S of Miles Rd. and 75 ft W of Walter St. SE. Recovery test indicated transmissibility about 30,000. Depth to water measurement was made 7½ hrs. after pumping stopped.
32.141	H. Sheets	1949	Valley floor	4945	471	14	QTs	-	-	-	-	[illegible]	-	-	-	P	T,E	75	Well 2, San Jose field. Located at dead end extension of Topeka St. SE, about 150 ft S of San Jose Ave. SE. See analysis.
32.231	do.	1949	do.	4949	304	13	QTs	-	-	-	-	[illegible]	-	-	-	P	T,E	-	Well 1, San Jose field. Located in yard of San Jose pumping station about 30 ft S of San Jose Ave. SE, and 30 ft W of Galena St. SE.
32.333	do.	1950	do.	4944	321	14	QTs	-	-	-	-	[illegible]	-	-	-	P	T,E	-	Well 6, San Jose field. Located about 100 ft S of Descanso Rd. SE, and 75 ft W of San Jose Interior Drain.
32.411	do.	-	do.	4946	163.3	6	Qal,QTs	7.03	9-1-57	Top of casing	3.5	-	-	-	-	O	N	-	Located 5 ft S of Wesmeco Dr. SE, and 75 ft W of John St. SE. Equipped with recording gage.
32.412	do.	1949	do.	4953	504	14	QTs	-	-	-	-	[illegible]	-	-	-	P	T,E	-	Well 3, San Jose field. Located about 50 ft N of Wesmeco Dr. SE, at intersection of Arno St. SE.
32.414	do.	1949	do.	4949	510	14	QTs	-	-	-	-	[illegible]	-	-	-	P	T,E	-	Well 4, San Jose field. Located about 0.15 mi S of Wesmeco Dr. SE, and 50 ft W of Arno St. SE.
32.434	do.	1949	do.	4950	470	14	QTs	-	-	-	-	[illegible]	-	-	-	P	T,E	-	Well 5, San Jose field. Located about 0.4 mi. S of Wesmeco Dr. SE, and 30 ft W of Arno St. SE.

TABLE 1 (continued)

Location	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diam. of well (in.)	Principal water-bearing bed	Water level: Below lsd	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above lsd	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Remarks
10. 4. 5.122	Roscoe Moss Co.	1959	East mesa	5490	1224	16	QTs	525	1-9-59	Land surface	0	2400M	1-9-59	46M	3	P	T,E	73	Well 2, Thomas field. Located at S side of Montgomery Blvd. 0.4 mi. E of Wyoming Blvd. NE. Recovery test indicated transmissibility about 100,000. Depth to water determined by air gage.
16.334	do.	1955	do.	5462	1170	18-14	QTs	502	1955	-	-	1725R	1955	87R	-	P	T,E	75	Well 1, Love field. Located about 0.18 mi. E of Eubank Blvd. NE, and 200 ft S of Lomas Blvd. NE. Well cased to 1,096 ft. See analysis. See log.
20.111	do.	1958	do.	5367	1284	16	QTs	413.07	8-3-58	Top of casing	2.0	2335M	8-6-58	35M	6	P	T,E	71	Well 4, Love field. Located about 200 ft S of Lomas Blvd. and 200 ft E of Wyoming Blvd. NE. Test indicated transmissibility about 240,000. See analysis.
20.143	do.	19[illegible]	do.	5393	1248	16	QTs	444.27	8-5-58	do.	2.0	2300M	7-25-58	40M	18	P	T,E	-	Well 5, Love field. Located 250 ft N of Copper Ave. and 80 ft E of General Hodges St. NE extended. Test indicated transmissibility about 180,000.
20.212	do.	1958	do.	5410	1280	16	QTs	447.97	3-4-59	Top of measuring pipe	2.0	2375M	8-26-58	47M	15	P	T,E	-	Well 3, Love field. Located about 200 ft S of Lomas Blvd. and 0.36 mi. W of Eubank Blvd. NE. Test indicated transmissibility about 110,000.
20.244	do.	1958	do.	5440	1224	16	QTs	496.1	7-22-58	Hole, north side of casing	.5	1800M	7- 3-58	80M	26	P	T,E	72	Well 2, Love field. Located 230 ft N of Copper Ave. and 250 ft W of Eubank Blvd. NE. Test indicated transmissibility about 75,000.
11.2.36.442	do.	1955	Valley floor	4967	924	-	QTs	14	1955	-	-	2300R	1955	140R	-	P	T,E	-	Well 3, Griegos field. Located about 0.25 mi. W of Rio Grande Blvd. NW, on unnamed road to W which is about 200 ft S of San Lorenzo Ave. NW. Well cased to 916 ft.
11.3.31.214	H. Sheets	-	do.	4974	152.0	6	Qal,QTs	17.67	8-1-57	Top of casing	6.0	-	-	-	-	O	E	-	Located on E side of Griegos Drain at dead end of Adobe Rd. NW, and about 0.3 mi. E and 0.2 mi S of Rio Grande Blvd. NW. Equipped with recording gage.
31.231	Roscoe Moss Co.	1955	do.	4973	834	-	QTs	13	1955	-	-	2500R	1955	119R	-	P	T,E	66	Well 1, Griegos field. Located in yards of Griegos pumping station S of intersection of Griegos Drain and Griegos lateral about 0.15 mi. E of Rio Grande Blvd. NW. Well cased to 802 ft. See analysis.
31.442	do	1958	do.	4969	813	16	QTs	16.65	10-14-58	Top of measuring pipe	2.0	2320M	10-11-58	118M	20	P	T,E	-	Well 5, Griegos field. Located about 200 ft N of Griegos Rd. and 80 ft E of Guadalupe Rd. NW. Test indicated transmissibility about 90,000.
32.143	do.	1955	do.	4972	837	-	QTs	13	1955	-	-	2275R	1955	109R	-	P	T,E	-	Well 4, Griegos field. Located at intersection of Guadalupe Trail NW, and Montano Rd. NW about 200 ft W of Guadalupe Trail NW. Well cased to 804 ft.
33.144	H. Sheets	1953	do.	4980	143.8	6	Qal,QTs	11.03	8-1-57	Top of casing	5.2	-	-	-	-	O	N	-	Located at dead end of Sandia Rd. NW, about 75 ft W of A.T.&S.F. RR tracks. Equipped with recording gage.
36.322	Roscoe Moss Co.	1960	East mesa	5360	1018	16	QTs	302.40	2-8-60	Hole in pump base	2.0	2400M	2- 7-60	30M	5	P	T,E	-	Well 3, Lyendecker field. Located about 0.5 mi. N of Montgomery Blvd. and about 100 ft W of San Pedro Blvd. extended, NE. Test indicated transmissibility about 600,000.
36.422	do.	1960	do.	5325	1018	16	QTs	350.78	1-27-60	do.	2.0	2400M	1-26-60	40M	5	P	T,E	-	Well 4, Lyendecker field. Located about 0.4 mi. N of Montgomery Blvd. and about 100 ft W of Louisiana Blvd. NE, extended. Test indicated transmissibility about 530,000.
36.434	do.	1959	do.	5287	1000	16	QTs	322.48	12-10-59	Top of measuring pipe	0	2475M	12-10-59	21M	5	P	T,E	-	Well 1, Lyendecker field. Located about 100 ft N of Montgomery Blvd. and 0.25 mi. W of Louisiana Blvd. NE. Test indicated transmissibility about 530,000.
11.4.31.412	do.	1959	do.	5400	1200	16	QTs	452	1-28-59	Land surface	0	2425M	1-27-59	37.5M	5	P	T,E	71	Well 3, Thomas field. Located 2,320 ft N of Montgomery Blvd. and 1,325 ft W of Wyoming Blvd. extended, NE. Test indicated transmissibility about 280,000.
32.321	do.	1958	do.	5480	1080	16	QTs	516.74	3- 4-59	Top of casing	1.5	2335M	12-15-58	37M	5	P	T,E	-	Well 4, Thomas field. Located 2,190 ft N of Montgomery Blvd. and 1,670 ft E of Wyoming Blvd. extended NE. Test indicated transmissibility about 300,000.
32.333	do.	1959	do.	5443	1093	13	QTs	478.15	3- 4-59	do.	1.5	2200M	1-20-59	24M	5	P	T,E	-	Well 1, Thomas field. Located about 100 ft N of Montgomery Blvd. and 300 ft E of Wyoming Blvd. NE. Test indicated transmissibility about 400,000.
12.4. 6.313	H. Sheets	1937	Valley floor	5047	500	10	QTs	15.41	10-29-56	Hole in pump base	1.5	400R	-	50R	-	P	T,E	64	Well 2. Located in old powerhouse in Bernalillo. See analysis.
6.323	Turner	1949	do.	5048	338	13	QTs	6	10-29-56	-	-	250R	-	90R	-	P	T,E	-	Well 1. Located about 800 ft NW of well 2.

TABLE 2

RECORDS OF INDUSTRIAL AND PUBLIC-SUPPLY WELLS OTHER THAN MUNICIPALLY OWNED WELLS IN THE ALBUQUERQUE AREA, BERNALILLO AND SANDOVAL COUNTIES, N. MEX.

Location number: Designates well and its location. (See well-numbering system.)
Altitudes of wells are estimated from topographic maps; altitude above sea level (ft).
Type of well: All wells listed are drilled unless otherwise noted in remarks.
Depth of well and water level: Measured depths are given to nearest tenth of a foot; reported depths are given in feet.
Principal water-bearing bed: Gravel and sand in the alluvium of Quaternary age, Qal; and the Santa Fe group of Quaternary and Tertiary age, QTs.

Yield and drawdown: E, estimated; M, measured; R, reported.
Use of water: D, domestic; I, irrigation; In, industrial; N, none; P, public supply other than municipal; O, observation.
Method of lift: A, air lift; C, centrifugal pump; Cy, cylinder pump; J, jet pump; N, no pump; T, turbine pump; Ts, submersible turbine pump; E, electric; S, steam.

BERNALILLO COUNTY

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above (+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Remarks
9.2. 2.444	Barcelona Elementary School	-	1950	Valley floor	4,932	90	6	QTs or Qal	-	-	-	-	-	-	-	-	P	T, E	-	Quality reported very good. Well is at NE corner of school.
12.322	Valley Utilities, Inc.	H. Sheeta	1956	do.	4,828	241	12	Qal and QTs	10.5	7-12-56	Top of tee on airline	+2.6	500	-	23	2	P	T, E	-	Supply for Adobe Acres. See analysis. See log. Well is 0.2 mi. W of U.S. 85.
23.242	Pajarito Elementary School	-	1955	do.	4,912	60	6	Qal	-	-	-	-	-	-	-	-	P	J, E	-	Reported hard but good. Well is at E end of school.
26.323	C. Warren Jonas Indian School	-	1956	do.	4,906	58	8	Qal	7	12-13-56	Land surface	-	-	-	-	-	P, I	C, E	-	Reported good. Well is 0.4 mi. W of Isleta Rd. and 200 ft N of Markhem Rd.
35.443	Los Padillas Elementary School	-	1954	do.	4,900	60	6	Qal	10	-	do.	-	-	-	-	-	P	J, E	-	Well is about 150 ft W of Isleta Rd. and 100 ft N of Los Padillas Rd.
9.3. 1.112	U. S. Government	-	1949	East mesa	5,318	1,000	14	QTs	380.1	4- 9-57	Hole in pump base	+3.5	655R	-	6R	-	In, P	T, E	63	Sandia well 2. See analysis.
1.222	do.	Roscoe Moss Co.	1954	do.	5,349	1,000	-	QTs	400.9	4- 9-57	Top air clean-out line	+1.5	980R	-	10R	-	In, P	Ts, E	62	Sandia well 7. See analysis.
5.111	Schwartzman Packing Co.	-	1932	do.	4,936	-	12	Qal	-	-	-	-	200R	-	-	-	In	T, E	-	Standby well for fire protection. Well is about 300 ft W of RR tracks and 0.25 mi. N of Schwartzman plant. Well 3.
5.222	Albuquerque Moulding Co.	F. Honeycutt	1952	Slope east of valley floor	5,000	110	5	QTs	78	-	Land surface	-	-	-	-	-	In, D	J, E	-	Reported very good; use mostly for fire protection. Well is 0.35 mi. E of S. Broadway and 250 ft S of gravel road.
5.234	State-Wide Products Co.	do.	1953	do.	4,870	83	8	QTs	60	-	do.	-	20M	-	-	-	In	Ts, E	69	Averages 15 hrs. per day. Manufacture of potato chips, well is 0.83 mi. S of Woodward Rd. and about 300 ft E of S. Broadway. See analysis.
5.314	A.T. & S.F. Co.	Riggs	1826	Valley floor	4,934	67	17	Qal	6.9	10-18-56	Top of manhole	+1.0	1000R	-	9R	-	In	Cy, S	-	Standby well for tie-treating plant. Well is about 450 ft E of RR tracks and 400 ft S of drive-in.
6.242	Schwartzman Packing Co.	-	1840	do.	4,935	256	10	QTs	-	-	-	-	150R	-	-	-	In	T, E	-	Quality reported good. Well is pumped 16 hrs. per day every day. Used in processing meat. Well is in shed behind boiler room. Well 1.
6.24[illegible]	do.	-	1832	do.	4,935	168	10	QTs	-	-	-	-	150R	-	-	-	In	T, E	-	Quality reported good. Used in processing meat 11 hrs. a day. Well is in shed in field in front of plant. Well 2.
6.24[illegible]	do.	-	1847	do.	4,935	70	10	Qal	-	-	-	-	150R	-	-	-	In	T, E	67	Reported hard. Used for ammonia condensers 12 hrs. every day. Well is in shed S of plant. Well 4.
8.221	Public Service Co., Persons Station	McDonald	1951	Slope east of valley floor	5,010	725	18	QTs	99.7	6-26-56	Hole in pump base	+1.5	860R	-	94R	-	In	T, E	-	Cooling towers and electrical plant use. Well is near NW corner of wire enclosure. Well 2.
8.223	do.	do.	1851	do.	5,020	728	16	QTs	95R	-	-	-	1000R	-	65R	-	In	T, E	-	Cooling tower and electrical plant use. Well is within wire enclosure near entrance gate.
8.441	New Mexico Dog Food Co.	H. Sheets	1855	do.	5,100	210	12	QTs	185R	-	Land surface	-	30R	-	-	-	In	Ts, E	70	Well used in processing, pumped 2 hrs. a day. Well is 0.6 mi. S of Persons Powerhouse and 0.35 mi. E of S. Broadway.
9.111	Public Service Co., Persons Station	McDonald	1956	do.	5,120	1,000	14	QTs	182.0	6-26-56	Hole in pump base	+1.0	2000R	-	142R	3	In	T, E	77	Cooling tower and electric plant use. Well is E of the plant in NE part of fence enclosure.
9.113	do.	H. P. Doty	1853	do.	5,130	920	30-14	QTs	-	-	-	+1.0	1000R	-	43R	-	In	T, E	77	Backfilled from 1,025 ft. Used for cooling towers and plant. Well is SE of plant. Well 3. See analysis.
18.213	Lourdes Boys Village	-	-	Valley floor	4,950	55	5	Qal	26.00	8-24-56	Pump house floor	+1.5	100R	-	-	-	P, I	C, E	-	Dug and drilled well. Pumped about 2 hrs. every day. Well is 0.25 mi. W of S. 2nd St. and 500 ft S of driveway.
9.4. 5.332	U. S. Government	Roscoe Moss Co.	1954	East mesa	5,376	1,000	16	QTs	434R	-	Land surface	-	855R	-	17R	-	In, P	Ts, E	62	Sandia well 8. See analysis.
6.414	do.	-	1949	do.	5,361	1,000	14	QTs	404.4	4- 9-57	Hole in pump base	+4.0	645R	-	5R	-	In, P	T, E	58	Sandia well 4. See analysis.
15.311	do.	Spain	1848	do.	5,500	684	10	QTs	536R	-	Land surface	-	200R	-	58R	500	-	-	-	-

TABLE 2 (continued)

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of wall (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Remarks
8.4.20.221	U. S. Government	H. P. Doty	1959	East mesa	5,425	1,036	12	QTs	458.5	6-12-59	Top of casing	-	400M	7- 7-59	74M	6	In	T, E	73	Test indicated transmissibility about 7,500. See analysis.
10.1.30.220	do.	Layne-Texas Co.	-	West mesa	5,955	1,385	9	QTs	935	-	-	-	32R	4-17-55	84R	6	In	Cy, E	-	See analysis. See log.
10.2. 2.212	College of St. Joseph	H. Sheets	1851	do.	5,112	250	10	QTs	-	-	-	-	500R	-	-	-	P	T, E	-	Reported very good water, pumps from 4 to 6 hrs. a day. Well is 0.18 mi. E of Corona Dr. and 0.08 mi. N of entrance road. See analysis.
26.133	Acoma Corp.	-	1956	do.	5,010	110	8	QTs	74.63	10-25-56	Hole in casing cover	-1.0	50R	-	4R	-	In	Ts, E	-	Water reported good. Machine shop use. Well is 0.4 mi. W of Coors Rd. and 250 ft S of Tower Rd.
26.424	Atrisco Elementary School	H. Sheets	1854	Valley floor	4,939	60	6	Qal	-	-	-	-	-	-	-	-	P	J, E	-	Water is hard but good. Well is 300 ft S of San Ygnacio Rd. and 100 ft W of Atrisco Rd.
36.413	Ernie Pyle School	Aqua Drilling Co.	1853	do.	4,934	60	6	Qal	12R	-	-	-	60R	-	2R	-	P	T, E	-	Water reported hard. Well is 0.25 mi. W of Isleta Rd. and 150 ft S of Valdora Rd.
10.3. 7.412	St. Anthony's Orphanage	-	1830	do.	4,960	150	8	Qal or QTs	-	-	-	-	150R	-	-	-	P	T, E	-	Well is 0.25 mi. W of 12th St. and 500 ft S of Indian School Rd.
7.441	Public Service Co. Prager Station	-	1938	do.	4,960	243	10	QTs	-	-	-	-	400R	-	-	-	In	T, E	-	Standby well for cooling towers. The cooling water is about half consumed before wasting into drains. Well is about 200 ft W of power plant. Well 1.
7.441a	do.	H. Sheets	1841	do.	4,980	399	10	QTs	15R	-	-	-	300R	-	10R	-	In	T, E	-	Supplies make-up water for cooling towers. Well is about 250 ft E of power plant. Well 2.
7.441b	do.	do.	1948	do.	4,960	723	12	QTs	-	-	-	-	750R	-	91R	-	In	T, E	-	Supplies make-up water for cooling towers. Well is near W side of power plant. Well 3. See log.
8.311	United Pueblos Indian Agency	-	-	do.	4,961	212	12	QTs or Qal	19.0	11-28-56	Hole in pump base	+1.0	-	-	-	-	P, In, I	T, E	-	Standby well for public supply and fire protection. Otherwise is used to water grounds. Well is 500 ft E of 12th St. and 400 ft N of Indian School Rd.
8.433	Creamland Dairies, Inc.	H. Sheets	1948	do.	4,860	172	10	QTs	-	-	-	-	260R	-	18R	-	In	T, E	66	Pumps about 225,000 gpd. Quality reported good. Well is at NW corner of plant building.
9.124	Albuquerque Sand and Gravel Co.	-	-	Slope east of valley floor	5,015	-	14	QTs	61.4	10- 5-56	Hole in steel well cover	+1.5	-	-	-	-	N, O	N	-	Well formerly used for washing gravel, now used for observation. Well is about 0.35 mi. N of Menaul Blvd. and 0.25 mi. E of Edith Blvd.
8.134	Menaul School	E. T. Hoard	1955	Valley floor	5,001	266	10	QTa	90.7	7- 5-56	End of 2-in. pipe into casing	-4.9	100R	-	-	-	P, I	T, E	-	Pumps about 75,000 gpd. Well is NE of intersection of Menaul Blvd. and Edith Blvd. NE.
15.331	University of New Mexico	H. Sheets	1950	Arroyo on east mesa	5,115	306	-	QTs	160R	1950	Land surface	-	850R	-	-	-	P, I	T, E	-	All uses for University. Well is about 300 ft N of Lomas Blvd. and 50 ft E of Yale Blvd. NE. Well 4.
15.334	do.	do.	1847	do.	5,138	304	18	QTe	186.40	4-18-57	Top of pump platform	-8.0	-	-	-	-	P, I	T, E	-	All uses for University. Well is on golf course 200 ft N and 400 ft W of intersection of Lomas Blvd. and Stanford Dr. NE. Well 3.
17.122	Valley Gold Dairies, Inc.	do.	1842	Valley floor	4,959	60	-	Qal	-	-	-	-	-	-	-	-	In	T, E	-	All dairy uses. Well is in recess on E side of building on the SE corner of 4th St. and Hannet Ave. NW.
17.333	Leggatts Laundry	-	1935	do.	4,952	60	8	Qal	21.4	10-12-58	Top of casing	-6.0	160R	-	21R	-	In	T, E	-	Standby well since 1952. Well is in pit beneath building. Well is about 100 ft N of Tijeras Ave. and 100 ft E of 8th St.
17.342	American Linen and Supply Co.	-	1940	do.	4,955	125	6	Qal	25R	-	Land surface	-	80R	-	15R	-	In	T, E	-	Pumped 30,000 gpd. Water is processed and used in laundry. Well is about 200 ft E of 3rd St. and 50 ft N of Roma Ave.
17.343	Bernalillo County Court House	-	1925	do.	4,956	520	-	QTa	25R	-	do.	-	-	-	-	-	P, I	T, E	64	Water is chlorinated, is public supply for building. Well yields 10 lbs of sand every 90 days. Irrigates 3 acres. Well is in open pit at N side of court house. See analysis.
17.432	Albuquerque Ice Co.	-	-	do.	4,955	200	4	QTs	-	-	-	-	20R	-	-	-	In	J, E	70	Quality reported good. Water used for ice, makes 10,000 tons a year. Well pumped 6 hrs. every day. Well is in pumphouse 260 ft N of Roma Ave. and 50 ft W of Commercial St. NE.

TABLE 2 (continued)

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Remarks
10.3.17.432a	Albuquerque Ice Co.	-	-	Valley floor	4,955	100	8	Qal	-	-	-	-	400R	-	-	-	In	T, E	E8	Water reported hard. Used on condensers 24 hrs. every day. Well is in main building about 250 ft N of Roma Ave. and 30 ft W of Commercial St. NE.
17.433	Excelsior Laundry Co.	-	1940	do.	4,955	400	16	QTs	24.1	10-16-56	Top of casing	-6.5	150R	-	-	-	In	T, E	-	Pumped 75,000 gpd, pumped 8 hrs. a day into open tank. Well is in pit in alley between 1st and 2nd Sts. and on the S side of Roma Ave. NW.
17.434	Coca-Cola Bottling Co.	-	1947	do.	4,954	500	12	QTs	-	-	-	-	-	-	-	-	In	T, E	-	Bottling, rinsing, and washing use. Well is 150 ft N of Marquette Ave. on the E side of Commercial St. NE.
17.441	Sanitary Laundry	-	1928	do.	4,956	72	E	Qal	25	-	-	-	110R	-	9R	-	In	T, E	-	Used for laundry. Well is in building at Broadway Blvd. and Fruit Ave. NE near alley.
19.221	Washington Junior High School	-	1925	do.	4,951	60	6	Qal	-	-	-	-	-	-	-	-	P, I	T, E	-	Used mostly for sprinkling of lawns. Well is 500 ft N of W. Park Ave. and 500 ft W of 10th St. NW.
20.114	El Fidel Hotel	Turner Drilling Co.	1950	do.	4,952	235	8	QTs	25	-	Land surface	-	150R	-	40R	-	P, In	T, E	-	All uses for hotel. Well is in pit near the loading platform on the N side of hotel.
20.114a	Franciscan Hotel	H. Sheets	-	do.	4,952	-	6	QTs or Qal	25	-	do.	-	-	-	-	-	P, In	T, E	-	All uses for hotel. Pumps some sand. Well is in pit in alley N of hotel about 150 ft W of 6th St. NW.
20.122	Korber Realty, Inc.	do.	1927	do.	4,953	255	7	QTs	22.6	10- 4-5E	Hole in east side of casing	-7.9	-	-	-	-	P, In	T, E	-	Not used since 1954. Supplied Korber Bldg. Sand troublesome. Bacterial contamination in 1954. Well is in basement of garage E of Korber Bldg.
20.123	F. W. Woolworth Co.	-	1941	do.	4,952	E8	8	Qal	-	-	-	-	-	-	-	-	In	T, E	-	Used for air conditioning, refrigeration system. Pumped 7 hrs. a day for 5 months. Well is beneath the building N of Central Ave. and E of 4th St. NW.
20.124	Barnett Estate (Sunshine Bldg.)	-	1924	do.	4,953	333	10	QTs	-	-	-	-	-	-	-	-	In	T, E	-	Not used since 1943. Discontinued when sand became troublesome. Well is in basement of building on SE corner of Central Ave. and 2nd St. SW.
20.124a	Hilton Hotel	-	1939	do.	4,953	250	10	QTs	-	-	-	-	150R	-	-	-	P	T, E	70	Water supply for hotel. Pumped almost constantly. Pumps some sand. Connected with city lines for emergency. Well is beneath sidewalk on W side of 2nd St. near alley S of Copper Ave. NE. Water reported good. See analysis.
20.124b	do.	-	1939	do.	4,953	60	10	Qal	-	-	-	-	100R	-	-	-	In	T, E	70	Water removes heat from air refrigeration units and is discharged directly into sewer. Pumped almost constantly in summer. Well is beneath sidewalk near well 10.3.20.124a. See analysis.
20.141	Simms Building	-	1953	do.	4,951	265	12	QTs	1E.4R	3-18-53	Land surface	-	300R	-	14R	2	In	T, E	-	Well 1. Cools building; water is pumped through heat pump into well 2 in summer. Has pumped 50 to 60 cubic yards of sand which was replaced by gravel. Water is sampled periodically by owner. Well is beneath loading platform on S side of building. Water is treated. Well has improved with use. See log.
20.141a	do.	-	1953	do.	4,951	72	12	Qal	1E.4R	3-18-53	do.	-	375R	-	23R	2½	In	T, E	-	Well 2. Heats building; water is pumped through heat pump into well 1 in winter. Well is beneath loading platform on S side of building. Water is treated chemically and sampled periodically. Well has improved with use.
20.142	Imperial Laundry	H. Sheets	1939	do.	4,951	449	-	QTs	-	-	-	-	155R	-	35R	-	In	T, E	-	Pumped about 8 hrs. a day. Well is in pit beneath shed about 50 ft N of Silver Ave. and E of 3rd St.
20.222	St. Joseph's Sanatorium and Hospital	do.	1915	Slope east of valley floor	4,995	100	14	QTs	-	-	-	-	400R	-	20R	-	P, In, I	T, E	-	All uses for hospital. Pumped about 6 hrs. a day. Water is chlorinated. Well is in shed on S side of Marquette Ave. about 150 ft E of Walter St. NE.

TABLE 2 (continued)

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of wall (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Remarks
10.3.20.344	A.T. & S.F. Co.	Raven	1924	Valley floor	4,947	418	10	QTs	10R	-	-	-	432R	-	90R	-	In, P	A	-	Used by railroad, other industries and Alvarado Hotel. Water is chlorinated. Well 8. Well is about 50 ft E of round house in RR yards. See analysis.
20.412	Darrow Ice Cream Co.	H. Sheets	1937	Edge of valley floor	4,973	80	4	QTs	-	-	-	-	60R	-	-	-	In	T, E	-	Pumped 24 hrs. a day. Well is in pit beneath loading platform at Coal Ave. and Arno St. SE.
21.223	University of New Mexico	-	1942	East mesa	5,155	342	16	QTs	203.0	4-25-57	Top of manhole curb	+0.5	435R	-	-	-	P, I	T, E	-	All uses for University. Well is E of boilerhouse. Well is about 1,000 ft N of Central Ave. and 300 ft W of Terrace Drive NE. Well 2.
21.243	do.	Walking	1954	do.	5,160	272	36	QTs	210.3	4-30-57	Top of well curb	+1.0	425R	-	-	-	P, I	T, E	-	All uses for University. Well is about 300 ft N of Central Ave. and about 75 ft W of Terrace Dr.
21.433	Albuquerque Board of Education	H. Sheets	1954	Slope of east mesa	5,140	323	10	QTs	-	-	-	-	520R	-	68R	-	P, I	T, E	-	Used at about 300 gpm. Supplies Administration Bldg. and several schools. Well is in shed on bluff E of the Administration Bldg. See analysis.
29.121	A.T. & S.F. Co.	-	1923	Valley floor	4,946	523	10	QTs	-	-	-	-	320R	-	18R	-	In, P	A	-	Used by railroad, other industries and Alvarado Hotel. Pumped at 509 gpm. Well is W of Roundhouse Office Bldg. Well 9.
29.122	do.	Riggs	1923	do.	4,946	304	10	QTs	-	-	-	-	240R	-	36R	-	In, P	A	-	Used by railroad, other industries and Alvarado Hotel. Well is SE of roundhouse at S end of reservoir. Well 7.
29.314	Albuquerque sewage disposal plant	-	1938	do.	4,939	40	10	Qal	7.6	10-18-56	Top edge of manhole	+ .3	-	-	-	-	In, O	N	-	Well drilled for observation and emergency at sewage disposal plant. There also are four aquifer de-watering wells nearby. Well is near tanks at plant.
30.141	Five Points Elementary School	-	1954	do.	4,943	60	6	Qal	6	-	Land surface	-	-	-	-	-	P	T, E	-	All uses for school. Well is between school buildings. 150 ft W of Hartline Rd. and 50 ft S of Airway Rd.
31.114	Old Armijo School	Aqua Drilling Co.	1954	do.	4,941	60	6	Qal	-	-	-	-	-	-	-	-	P	J, E	-	All uses for school. Well is 100 ft N of Isleta Rd. and 50 ft E of Gatewood Rd.
32.323	Eidal Manufacturing Co.	Briner Rustproofing Co.	1950	do.	4,941	48	-	Qal	-	-	-	-	-	-	-	-	In, D	T, E	-	Uses in machine shop. Well is about 300 ft S of Woodward Rd. and about 700 ft E of RR tracks.
32.323a	Edgar D. Otto & Son, Inc.	-	1950	do.	4,940	48	6	Qal	12R	-	Land surface	-	31R	-	-	-	In	C, E	-	Used in making construction blocks. Pumped 6 hrs. a day. Well is 400 ft S of Woodward Rd. and 400 ft E of RR tracks.
32.324	A. C. F. Industries, Inc.	T & P Pump Co.	1953	do.	4,942	65	8	Qal	11R	-	do.	-	350R	-	-	-	In	T, E	-	All plant uses, pumped 16 hrs. a day. Well is in building about 700 ft W of Broadway Blvd. and 200 ft S of Woodward Rd.
32.324a	Mac's Cafeteria	-	1956	do.	4,944	60	2	Qal	-	-	-	-	-	-	-	-	P	Cy, E	-	All cafeteria uses. Pumped about 5 hrs. a day. Well is about 600 ft W of Broadway Blvd. and 75 ft N of Woodward Rd.
32.342	A. C. F. Industries, Inc.	T & P Pump Co.	1956	do.	4,942	65	8	Qal	11R	-	Land surface	-	350R	-	-	-	In	T, E	-	Use mostly for fire protection. Water is hard and is analyzed periodically. Well is beneath water tower about 600 ft W of Broadway Blvd. and 600 ft S of Woodward Rd.
32.432	Standard Oil Co. of Texas	Aqua Drilling Co.	1952	East edge of valley floor	4,948	170	-	QTs	15R	-	do.	-	-	-	-	-	In, I	T, E	-	Fire protection for oil yard and domestic use. Pumped about 1 hr. a day. Well is about 500 ft E of Broadway Blvd. and about 250 ft S of Woodward Rd.
32.433	The Texas Co.	do.	1955	Valley floor	4,945	66	10	Qal or QTs	-	-	-	-	-	-	-	-	In, I	T, E	-	All uses around oil yard. Irrigates about 3 acres. Well is about 1,200 ft S of Woodward Rd. and about 250 ft E of Broadway Blvd.
34.144	U. S. Government	Layne-Texas Co.	-	East mesa	5,301	1,010	16	QTs	357.6	2-20-56	Top of casing	+4.0	-	-	-	-	In, P	T, E	-	Kirtland well 2. See analysis. Test indicated transmissibility about 100,000.

TABLE 2 (continued)

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Remarks
).3.35.111	U. S. Government	H. P. Doty	1952	East mesa	5,320	1,000	36-16	QTs	-	-	-	-	925R	-	14R	-	In, P	T, E	-	Kirtland well 1. See analysis.
36.132	Veterans Administration Hospital	B & W Drilling Co.	1956	do.	5,342	1,000	14	QTs	392.0	5-14-56	Top of casing	+4.0	1000M	5-21-56	14.5M	26	P, In, I	N	68	Intended for all hospital uses. Well is on SE side of road behind storage tanks. See log. See analysis. Test indicated transmissibility about 320,000.
.4.18.421	Albuquerque Gravel Products Co.	-	-	do.	5,355	433	8	QTs	391	-	-	-	-	-	-	-	In	Cy, E	-	Supplies concrete mixing plant. Well is SW of Wyoming Blvd. and Constitution Ave. NE.
29.413	U. S. Government	H. P. Doty	1952	do.	5,434	1,004	14	QTs	473.1	4- 9-57	Bottom of pump base	+3.5	540R	-	-	-	In, P	T, E	71	Sandia well 5. See analysis.
30.321	do.	-	1949	do.	5,354	900	14	QTs	401R	-	Land surface	-	680R	-	6R	-	In, P	T, E	58	Sandia well 3. See analysis.
31.411	do.	-	1949	do.	5,383	1,200	12	QTs	436R	-	do.	-	577M	7- 4-58	11M	88	In, P	T, E	58	Sandia well 1. See analysis. Test indicated transmissibility about 450,000.
31.411a	do.	-	-	do.	5,385	-	-	QTs	435.8	4- 9-57	Top of casing	+1.0	-	-	-	-	N	N	-	Test hole.
32.433	do.	H. P. Doty	1952	do.	5,421	1,006	14	QTs	466R	-	Land surface	-	590R	-	22R	-	In, P	T, E	62	Sandia well 6. See analysis.
3. 9.323	Southern Union Gas Co.	Turner Drilling Co.	1951	do.	4,995	160	8	QTs	5.4	10-30-56	Top of casing	+1.0	1000R	-	100R	-	In	T, E	-	Plant for supplementing natural gas with propane. Water is for cooling towers. Well is about 500 ft E of Rio Grande Blvd. and about 400 ft 6 of Corrales Rd.
10.334	Alameda Elementary School	-	1954	do.	4,995	60	6	Qal	-	-	-	-	-	-	-	-	P	J, E	-	All uses for school. Well is 100 ft N of W school building.
21.132	Ranchos School	-	1951	Valley floor	4,988	80	6	Qal	10R	-	Land surface	-	-	-	-	-	P	J, E	-	All uses for school. Water is hard and yields yellow precipitate. Well is in W building about 300 ft W of 4th St. and about 150 ft S of Los Ranchos Rd. See analysis.
23.111	Public Service Co.	McDonald	1957	East mesa	5,073	927	16	QTs	92.6	11-22-57	Top of casing	+2.0	1369M	11- 1-58	45M	51	In	T, E	60	Well is at NW corner of new powerplant enclosure. Test indicated transmissibility about 150,000.
23.112	do.	do.	1957	do.	5,083	300	7	QTs	105.39	10-30-58	do.	+1.0	150R	-	-	-	In	T, E	58	Well is at N side of new powerplant enclosure. See analysis.
23.121	do.	do.	1957	do.	5,096	850	16	QTs	117.6	11-22-57	do.	+1.5	2000R	-	46.5R	-	In	T, E	60	Well is at NE corner of new powerplant enclosure. See log.
29.314	Alvarado Elementary School	H. Sheets	-	Valley floor	4,977	60	6	Qal	-	-	-	-	-	-	-	-	P	J, E	-	Water reported good. Used for all school needs. Well is near the SW corner of school building.
29.411	Paradise Ranch Dairy	-	-	-	4,979	-	-	Qal	-	-	-	-	-	-	-	-	In	J, E	-	All dairy uses. Well is at N side of El Pariso Rd. about 300 ft W of Guadalupe Rd.
33.322	Rainbo Baking Co.	Peerless Pump Co.	1955	Valley floor	4,980	70	4	Qal	10R	-	Land surface	-	200R	-	-	-	In, I	T, E	58	Not used in processing. Used in washing and watering yards. Well is 700 ft W of Edith Blvd. and 150 ft N of Montano Rd. See analysis.
33.433	Ribble Concrete Co.	Padilla	1958	Toe of westward slope	4,996	86	6	QTs	-	-	-	-	75R	-	-	-	In	T, E	-	Pumped about 5,000 gpd for mixing concrete. Well is 0.3 mi. S of Montano Rd. and 100 ft E of Edith Blvd.
34.141	Mission Avenue Elementary School	A. Milligan	1952	Slope east of valley floor	5,042	150	6	QTs	78.9	12-11-56	Top of casing	+2.5	-	-	-	-	P	T, E	62	Reported very good. Well is in the SE part of the building near the corner. See analysis.

TABLE 2 (continued)

SANDOVAL COUNTY

Location	Owner or name	Driller	Year com-pleted	Topo-graphic situation	Alt.	Depth of well	Diam-eter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measure-ment	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measure-ment	Drawdown: Amount (ft)	Drawdown: Dura-tion of test (hr)	Use of water	Method of lift	Tem-per-ature °F	Remarks
12.3.27.222	Sandia View Academy	H. Sheets	1956	Slope west side of valley	5,028	70	8	QTs or Qal	-	-	-	-	-	-	-	-	P	T, E	59	Water is very hard. Used for all school needs. Well is 0.3 mi. W of Corrales Rd. and 400 ft S of access road. See analysis.
34.142	Sandoval Element-ary School	do.	1956	Valley floor	5,011	60	6	Qal	-	-	-	-	-	-	-	-	P	J. E	-	Water reported good. Well is in pumphouse S of school building.
35.243	U. S. Bureau of Reclamation	-	1956	do.	5,010	15	-	Qal	-	-	-	-	500E	5- 8-56	-	-	In	C, G	51	Well points used to de-water formation for construction. See analysis.
12.4. 6.212	New Mexico Timber Co.	Turner Drilling Co.	1951	do.	5,045	50	8	Qal	6R	-	Land surface	-	-	-	-	-	In	T, E	-	Water reported hard. Used at intervals to de-water sediments underlying lumber kiln. Well is in shed 40 ft N of kiln.
6.212a	do.	H. Sheets	1946	do.	5,045	70	8	Qal	6R	-	do.	-	1,000R	-	-	-	In	T, E	-	Pumped almost constantly to de-water materials beneath lumber kiln. Water is pumped directly into land drains. Well is N and near old powerhouse about 900 ft NW of yard entrance.
13.4. 1.234	Plains Electric Cooperative, Inc.	do.	1953	do.	5,115	550	12	QTs	24R	-	do.	-	700R	-	42R	-	In, I	T, E	68	Standby for electric plant use. Otherwise used to help irrigate 30 acres surrounding plant. Well is near fence SW of plant and 325 ft SE of lower highway. Well 2. See log. See analysis.
1.243	do.	do.	1953	Near edge of valley floor	5,132	235	12	QTs	46R	-	do.	-	700R	-	13R	-	In, I	T, E	68	Standby well for plant use. Otherwise used to irrigate 30 acres around plant. Well is 110 ft from fence along upper highway and almost in line with NE edge of plant. Well 3. See analysis.
1.412	do.	do.	1952	do.	5,132	320	12	QTs	44R	-	do.	-	700R	-	12R	-	In	T, E	72	Pumped steadily at 450 gpm. Used in cooling towers and in plant. Well is in S corner of field near upper highway. Well 1. See analysis.
1.412a	do.	-	1957	do.	5,132	132	12	QTs or Qal	44R	-	do.	-	1,020R	-	24R	-	In	T, E	-	New well anticipated for plant use. Well is 30 ft N of well 13.4.1.412.
29.421	Southern Union Gas Co.	Turner Drilling Co.	1947	Valley floor	5,070	110	-	Qal	-	-	-	-	30R	-	-	-	In	J, E	-	Well is in rear of building of plant. See analysis.

TABLE 3

RECORDS OF LARGE-YIELDING IRRIGATION WELLS IN THE ALBUQUERQUE AREA, BERNALILLO AND SANDOVAL COUNTIES, N. MEX.

Location number: Designates well and its location. (See well-numbering system.)
Altitude of wells are estimated from topographic maps; above sea level (ft).
Type of well: All wells listed are drilled unless otherwise noted in remarks.
Depth of well and water level: Measured depths are given in tenths of a foot; reported depths are given in feet.
Principal water-bearing bed: Gravel and sand in the alluvium of Quaternary age, Qal, and the Santa Fe group of Quaternary and Tertiary age, QTs.
Yield and drawdown: E, estimated; M, measured; R, reported.
Use of water: I, irrigation; Is, irrigation to supplement surface-water supplies.
Method of lift: C, centrifugal pump; J, jet pump; T, turbine pump; N, no pump; B, butane; D, diesel; E, electric; G, gasoline; Gn, natural gas.
Acres irrigated: Reported.

BERNALILLO COUNTY

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above (+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Acres irrigated	Remarks
8.2. 1.312	R. Ward	-	1951	Valley floor	4,899	74	14	Qal	6.8	7- 9-56	Hole in pump base	+1.0	780M	7-18-56	30M	4	Is	T, E	57	45	About 1,300 ft SE of Malpais Rd. and U.S. 85. See analysis.
2.143	-	-	-	do.	4,898	-	6	Qal(?)	8.0	7-13-56	Top of casing	+ .6	-	-	-	-	Is	N	-	-	About 500 ft S of Santiago Rd. and Malpais Rd. Well and land not in use.
2.321	B. Abaakin	-	1953	do.	4,899	80	6	Qal	-	-	-	-	-	-	-	-	Is	C, G	-	8	About 1,000 ft SE of Santiago Rd. and Malpais Rd. Three 6-in. wells manifolded.
9.2. 2.214	Q. C. Bess	-	-	do.	4,934	72	16	Qal	-	-	Top of slot in casing	- .5	750E	8- 7-56	-	-	Is	T, Gn	58	50	About 600 ft NE of sharp curve in Foothill Rd. 0.35 mi. N of Blake Rd. Pumping level 20.0 ft, Aug. 7, 1956.
2.234	G. S. Barboa	-	-	do.	4,933	-	-	Qal(?)	-	-	-	-	-	-	-	-	Is	T, E	-	-	About 450 ft N of Blake Rd. 0.2 mi. E of Foothill Rd.
3.422	Baker Bros. Nursery	-	-	do.	4,940	-	12	QTs(?)	-	-	-	-	-	-	-	-	Is	T, E	-	-	About 500 ft S of Blake Rd. on W bank of Arenal Main Canal.
10.142	E. V. Mead	J. E. Smith	1952	do.	4,930	130	18	Qal & QTs	6.6	7-11-56	Hole in pump base	+1.8	1,200R	-	50R	-	Is	T, E	-	80	About 0.4 mi. W of Coora Rd. 0.4 mi. S of Barcelona Road.
10.242	B. Murray	-	1949	do.	4,929	76	16	Qal	7.4	7-25-56	Top of casing	+1.0	2,000R	-	-	-	Is	T, G	-	85	About 0.25 mi. E of Coora Rd. 0.4 mi. S of Barcelona Rd.
11.111	C. F. Wenk	E. T. Hoard	1954	do.	4,930	60	16	Qal	7.6	7-24-56	do.	0	860M	7-24-56	21M	1/12	Is	T, G	61	25	About 0.25 mi. E of Coors Rd. 0.15 mi. S of Barcelona Rd.
11.241	J. L. Ross	Davis	1954	do.	4,930	86	16	Qal	8.0	8- 1-56	do.	+ .8	1,150M	8- 1-56	31M	1/4	Is	T, E	60	33	About 300 ft S of Del Sur Dr. on W bank of Pajarito lateral.
11.321	C. P. Anderson	E. T. Hoard	1952	do.	4,931	75	16	Qal	8	7-16-56	do.	+1.2	1,800M	7-16-56	20M	1/2	Is	T, B	60	150	SE corner of Pajarito lateral and Arenal Main Canal (0.8 mi. SE of Coors and Barcelona Rds.).
12.134	do.	Buford Drilling Co.	1951	do.	4,928	86	16	Qal	10.1	7-16-56	Hole in pump base	+1.0	1,850M	7-16-56	22M	4	Is	T, Gn	60	150	About 0.4 mi. W of U.S. 85 on S side of road into Anderson Farm.
12.142	do.	Turner Drilling Co.	1927	do.	4,929	70	14	Qal	10.1	7-16-56	Top of casing	+2.0	700E	7-16-56	21M	1/12	Is	T, E	-	100	About 0.25 mi. W of U.S. 85 and Tobacco Rd. at SW corner of Y in irrigation canals.
12.334	O. C. Porter	-	1850	do.	4,926	-	10	Qal(?)	-	-	-	-	-	-	-	-	Is	C, G	-	10	About 600 ft N of Lakeview Rd. 0.2 mi. W of U.S. 85.
12.343	R. Bass	A. Milligan	1947	do.	4,926	48	8	Qal	-	-	-	-	350E	9-18-56	-	-	Is	C, G	58	8	About 400 ft NW of Lakeview Rd. and U.S. 85.
12.413	New Mexico State University	-	1954	do.	4,927	165	16	Qal & QTs	6.5	12-11-56	Top of casing	+1.0	1,350R	-	-	-	Is	T, Gn	59	50	About 300 ft E of U.S. 85 opposite entry to "Adobe Acres" Development.
13.134	N. Napoleone	-	1940	do.	4,924	65	-	Qal	-	-	-	-	650R	-	-	-	Is	C, G	-	10	About 400-500 ft NE of U.S. 85 and Sunshine Rd. (about 100 ft E of highway edge).
13.143	G. Everitt	-	1935	do.	4,925	65	6	Qal	-	-	-	-	400E	8-21-56	-	-	Is	C, E	60	12	About 100 ft E of U.S. 85, 0.1 mi. N of Sunshine Rd. (400 ft S of Everitt house).
14.123	Hesselden Bldg. Co.	E. T. Hoard	1950	do.	4,925	74	16	Qal	5	-	-	-	1,800R	-	27R	30	Is	T, E	-	100	Located at SW corner of Gun Club Rd. and Arenal Main Canal.
14.242	C. F. Wenk	do.	1954	do.	4,923	70	12	Qal	8.0	7-24-56	Hole in pump base	+ .5	1,000R	-	-	-	Is	T, E	-	35	About 400 ft S of Gun Club Rd. 0.35 mi. W of U.S. 85.
14.411	E. R. Wellborn	A. Milligan	1952	do.	4,921	53	12	Qal	-	-	-	-	900R	-	-	-	Is	C, G	-	4	About 600 ft N of Metzgar Rd. 0.6 mi. W of U.S. 85.
14.433	J. H. Cresswell	do.	1952	do.	4,918	60	16	Qal	-	-	-	-	750M	7-12-56	20R	-	Is	T, E	-	75	About 300 ft S of "North" Muniz Rd. 0.55 mi. W of U.S. 85.
14.43[illegible]	do.	-	1956	do.	4,918	45	4	Qal	14.5	7-10-56	Top of casing	.0	-	-	-	-	Is	C, E	-	-	Driven well. 150 ft NW of well 9.2.14.433. Nearby well pumping.
15.124	J. P. Hensley	A. Milligan	1946	Slope above valley	4,937	87	6	QTs	23.0	7-25-56	Bottom of slot in casing	+ .7	-	-	-	-	I	T, E	-	-	Driven well. 500 ft N and 1,000 ft W of Coors and Gun Club Rds.
15.221	Blumenshine Dairy	-	1948	Valley floor	4,923	72	12	Qal	-	-	Top of casing	+ .4	-	-	-	-	Is	T, E	-	30	About 1,000 ft NE of Coors and Gun Club Rds. Pumping level 32.6, July 11, 1956.

TABLE 3 (continued)

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Acres irrigated	Remarks
9.2.22.413	E. Cox	-	-	Valley floor	4,920	-	10	Qal(?)	-	-	-	-	620M	7-11-56	-	-	Is	T, B	61	30	At SE corner of Pajarito and Coors Rds.
22.441	do.	F. Honeycutt	1953	do.	4,910	120	10	Qal & QTs(?)	-	-	Top of casing	+1.1	550E	7-19-56	25R	2	Is	T, B	60	18	About 700 ft S of Pajarito Rd on W bank Arenal Main Canal. Pumping level 32.7, July 19, 1956.
23.321	O. A. Beck	-	1946	do.	4,914	57	6	Qal	-	-	-	-	500R	-	-	-	Is	C, G	-	5	About 600 ft SW of Beck and Don Felipe Rds.
23.333	G. Eden	F. Honeycutt	1953	do.	4,910	120	12	Qal & QTs(?)	10.1	7-19-56	Top of casing	+1.2	-	-	-	-	Is	T, B	-	12	About 800 ft SE of Pajarito Rd. and Arenal Main Canal (in SE corner of pasture).
24.311	Kaiser Farms	-	-	do.	4,915	-	5	Qal(?)	-	-	-	-	-	-	-	-	Is	C, G	-	20	About 800 ft E of Don Felipe Rd. and U.S. 85. Two wells manifolded to pump.
25.211	Valley Gold Dairies	H. Sheets	1955	do.	4,914	80	12	Qal	-	-	-	-	1000E	8- 2-56	-	-	Is	T, D	60	160	About 1.0 mi. W of S. 2nd St., 0.4 mi. S of S. 2nd St. Bridge over Tijeras Arroyo.
26.434	C. H. Taylor	-	1946	do.	4,905	80	10	Qal	-	-	-	-	700R	-	-	-	Is	C, G	-	-	About 500 ft W of U.S. 85, 800 ft S of Markham. (Not used for last 3 years.)
34.322	Denison Farms	-	1953	do.	4,910	-	-	QTs(?)	14.4	7-11-56	Hole in pump base	+1.6	-	-	-	-	Is	T	-	-	About 300 ft W of Coors Rd. 0.5 mi. N of Padilla Rd.
35.111	U. S. Bureau of Reclamation	-	1954	do.	4,906	95	16	Qal & QTs(?)	12.4	7-10-56	do.	+ .7	1400R	-	-	-	Is	T, Gn	-	*	About 3,200 ft N of Luchetti Rd. on W bank of Arenal Main Canal.
35.113	do.	-	1954	do.	4,905	115	16	Qal & QTs(?)	-	-	do.	+ .7	1100R	-	-	-	Is	T, Gn	62	*	About 2,300 ft N of Luchetti Rd. on W bank of Arenal Main Canal. Pumping level 43.4, July 10, 1956. See analysis.
35.122	James Gherardi	E. T. Hoard	1951	do.	-	102	12	Qal & QTa(?)	16	7-12-56	-	-	880M	7-12-56	12R	-	Is	T, G	60	33	About 2,700 ft N of Luchetti Rd. 0.4 mi. W of U.S. 85.
35.141	U. S. Bureau of Reclamation	-	1854	do.	4,904	105	16	Qal & QTs(?)	-	-	Hole in pump base	+ .8	1200R	-	-	-	Is	T, Gn	60	*	At SW corner of Arenal Main Canal and Indian lateral, 0.35 mi. N of Luchetti Rd. Pumping level 37.4 ft July 10, 1956.
35.142	do.	-	1954	do.	4,904	95	16	Qal & QTs(?)	-	-	do.	+ .7	1200R	-	-	-	Is	T, Gn	60	*	About 0.3 mi. N of Luchetti Rd. on bank between Los Padillas drain and Indian lateral. Pumping level 38.0 ft July 10, 1956.
35.143	M. A. Harkness	-	1949	do.	4,903	78	16	Qal	13.6	7-11-56	Top of casing	+1.5	1200R	-	-	-	Is	T, B	-	20	About 800 ft N of Luchetti Rd., 100 ft W of Arenal Main Canal.
35.212	E. M. Cordova	Rogers	1952	do.	4,905	42	5	Qal	-	-	-	-	180M	7-12-56	-	-	Is	C, G	-	7	Driven well. About 600 ft W of U.S. 85, 2,900 ft N of Luchetti Rd.
35.224	M. Luchetti	-	-	do.	4,905	-	12	Qal(?)	7.8	7-18-56	Top of casing	+ .8	-	-	-	-	Is	T	-	15	About 1,000 ft E of U.S. 85 and 2,500 ft N of Luchetti Rd. (on E bank of Los Padillas Acequia)
35.233	U. S. Bureau of Reclamation	-	1954	do.	4,903	95	16	Qal & QTs(?)	-	-	Hole in pump base	+ .7	1200R	-	-	-	Is	T, Gn	60	*	About 800 ft N of Luchetti Rd. on bank between Los Padillas drain and Indian lateral. Pumping level 39.8 ft July 10, 1956.
35.241	Joe Gherardi	E. T. Hoard	1851	do.	4,904	72	12	Qal	7	7-12-56	-	-	1100M	7-12-56	18R	3	Is	T, Gn	59	33	About 200 ft W of U.S. 85, 1,500 ft N of Luchetti Rd.
35.313	D. Powers	do.	1953	do.	4,901	101	18	Qal & QTs(?)	9.2	7-18-56	Hole in pump base	+1.4	800M	7- 9-56	29M	2	Is	T, B	61	58	About 20 ft S of Luchetti Rd., 0.8 mi. W of U.S. 85. Pumping level 38.2 ft July 9, 1956.
36.334	W. Arnett	-	1952	do.	4,902	77	12	Qal	5.1	7-10-56	Top of casing	+3.0	840M	7-10-56	25M	1/2	Is	T, B	56	-	About 0.3 mi. due E of U.S. 85 and Padilla Rd., on E bank of Indian lateral.
9.3.11.241	J. Carter	E. T. Hoard	-	Arroyo	5,160	341	18	QTa	210	-	-	-	1800R	-	59R	-	I	T, G	67	300	About 0.75 mi. above old Hicks Dairy in Tijeras Arroyo. See analysis.
17.324	W. Tarter	H. Sheets	1947	Alluvial fan	4,997	240	14	QTa	-	-	Hole in pump base	+ .5	-	-	-	-	I	T, E	-	-	About 700 ft E of S. Broadway, 0.7 mi. S of Prosperity Ave. (Not used for 4 yrs.) Dry at 47 ft Aug. 6, 1956.
18.214	Lourdes Boys Village	do.	1955	do.	4,958	150	16	Qal & QTa(?)	-	-	-	-	1000R	-	-	-	I	T, E	-	12	About 100 ft W of S. 2nd St., 500 ft S of drive into Lourdes Boys Village.
18.411	J. L. Phillips	-	1955	do.	4,95[illegible]	85	10	Qal	33.8	8- 3-56	Bottom of hole in casing	+ .2	540R	8- 3-56	8R	1/6	I	T, E	66	40	About 1,000 ft W of S. 2nd St., 500 ft S of Valley High Rd. (6 ft N of 3-ft cottonwood).

TABLE 3 (continued)

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Acres irrigated	Remarks
9.3.18.424	Balduini	H. Sheets	1950	Alluvial fan	4,978	125	14	Qal(?)	-	-	-	-	580M	8- 6-56	-	-	I	T, E	68	45	About 0.65 mi. S of Prosperity Ave., on W side of William St. SE.
18.442	do.	do.	1950	do.	4,979	125	14	Qal(?)	-	-	-	-	450E	8- 6-56	-	-	I	T, E	87	45	About 0.8 mi. S of Prosperity Ave., on W side of William St. SE.
18.322	H. Smith	Turner Drilling Co.	1952	do.	4,941	72	-	Qal	24.1	8- 2-56	Hole in pump base	+0.7	220M	8- 2-56	18M	1/6	I	T, E	66	10	About 200 ft S of Clark Rd., 400 ft W of S. 2nd St. See analysis.
10.2.13.422	Albuquerque Country Club	H. Sheets	1946	Valley floor	4,950	100	12	Qal & QTs(?)	-	-	-	-	800R	-	-	-	I	T, E	-	55	At edge of golf course behind 2308 W. New York Ave.
14.211	Gray's Flower Shop and Nursery	A. Milligan	1949	West mesa	5,090	162	10	QTs	140.3	12- 6-56	Hole in casing	+1.0	250R	-	-	-	I	T, E	61	9	About 300 ft N of Hanover St. and 200 ft SW of Atrisco Drive. See analysis.
26.334	C. G. Shambaugh	C. G. Shambaugh	1953	do.	5,002	110	12	QTs	-	-	-	-	550R	-	10R	-	I	T, E	-	15	About 1,000 ft W of Coors Rd. and 300 ft S of Sage Rd.
26.432	C. Garcia	-	1954	Valley floor	4,938	31	4	Qal	9.6	11-12-56	Face of pipe flange	+3.2	-	-	-	-	Is,O	N	-	-	-
38.324	Ernie Pyle School	Aqua Drilling	1854	do.	4,937	60	8	Qal	-	-	-	-	-	-	-	-	I	J, E	-	14	About 1,500 ft S of Arenal Rd. near W bank of Beckham lateral.
10.3. 4.124	E. L. Engel	-	-	Alluvial fan	4,995	-	-	Qal & QTs(?)	-	-	-	-	400E	9- 6-56	-	-	Is	T, E	62	-	About 600 ft N of Griegos Rd., 20 ft W of Edith Blvd. NE.
7.242	U. S. Indian School	-	1951	Valley floor	4,962	68	12	Qal	18.3	9- 5-56	Top of casing	+ .8	500E	9- 5-56	14R	-	Is	T, E	61	25	About 30 ft S of Menaul Blvd., 400 ft E of N. 12th St. See analysis.
7.424	do.	-	1951	do.	4,960	63	12	Qal	18.6	11-27-56	do.	+2.0	450E	10-16-56	-	-	Is	T, E	60	13	About 700 ft S of Indian School Rd., 400 ft E of N. 12th St.
9.131	Menaul School	E. T. Hoard	1927	Alluvial fan	4,994	130	12	Qal(?) & QTs	56.8	7- 5-56	Bottom of slot in casing	+ .8	450R	-	-	-	I	T, E	-	30	About 700 ft NE of Menaul Blvd. and Edith Blvd. NE.
9.144	do.	do.	1946	do.	5,010	157	16	QTs	74.8	7- 5-56	Hole in steel plate	+ .8	700R	-	-	-	I	T, E	-	-	About 0.25 mi. E of Edith Blvd., 100 ft N of Menaul Blvd.
9.321	Sunset Memorial Park	do.	1930	Westward slope	5,010	115	8	QTs	65	-	Land surface	0	400R	-	-	-	I	T, E	-	10	About 0.19 mi. E of Edith Blvd. and 300 ft S of Menaul Blvd.
9.32a	do.	T. & P. Pump Co.	1948	do.	5,010	150	12	QTs	85	-	do.	0	600R	-	-	-	I	T, E	-	10	About 0.20 mi. E of Edith Blvd. and 0.1 mi. S of Menaul Blvd.
16.112	Mt. Calvary Cemetery Assoc.	-	1930	do.	5,000	100	6	QTs	82	-	do.	0	-	-	-	-	I	T, E	-	3	About 0.1 mi. E of Edith Blvd. and 0.6 mi. S of Menaul Blvd.
16.112a	do.	R. Sheets	1948	do.	5,005	200	6	QTs	67.6	12- 7-56	Hole in casing	+1.5	-	-	-	-	I	T, E	-	8	About 0.12 mi. E of Edith Blvd. and 0.58 mi. S of Menaul Blvd.
19.111	Albuquerque Country Club	do.	1946	Valley floor	4,848	100	12	Qal & QTs(?)	5.7	12- 7-56	Hole in pump base	+1.0	1200R	-	8R	6	I	T, E	57	55	About 500 ft SW of Albuquerque Country Clubhouse near E bank of drain. See analysis.
10.4.34.214	Four Hills Country Club	Roscoe Moss Co.	1957	East mesa	5,600	1,200	18	QTs	816.2	9-30-57	Top of casing	+1.8	1625M	9-27-57	28.0M	3	I	T, E	59	-	Test 9-28-57 indicated transmissibility about 280,000. Well is S of Tijeras Arroyo about a mile below Tijeras Canyon. Irrigates a golf course. See analysis.
11.2.35.311	C. G. Shambaugh	-	1850	West mesa	5,118	185	12	QTs	155	-	Land surface	0	425R	-	10R	-	I	T, Gn	-	2	About 100 ft E of Atrisco Dr. and 0.8 mi. N of turnoff to St. Joseph's College.
36.131	do.	E. T. Hoard	1954	Valley slope	4,999	110	16	QTs(?)	38.8	11-27-56	Hole in casing	+1.0	650R	-	10R	-	I	T, G	-	60	About 3,500 ft N and 2,000 ft E of St. Joseph's College.
11.3. 4.124	M. Christ	A. Milligan	1953	Valley floor	5,001	70	16	Qal	6.2	8- 5-56	Top of slot in casing	+3.0	1000R	-	-	-	Is	T, G	-	-	About 750 ft S of County line, 500 ft NW of Corrales Rd.
4.132	Dr. Wright	A. Sheets	1953	do.	4,988	55	8	Qal	-	-	-	-	-	-	-	-	Is	C, G	-	20	About 0.3 mi. S of County line, 800 ft W of Corrales Rd.
4.134	R. Singer	do.	1952	do.	4,987	55	14	Qal	7.8	9- 5-56	Hole in pump base	+1.0	-	-	-	-	Is	T, G	-	-	About 0.4 mi. S of County line, 100 ft N of Corrales Rd. on W side of Corrales lateral.
4.222	W. A. Marga	-	1956	do.	5,005	85	8	Qal	4.5	9- 7-56	Top of casing	+ .9	-	-	-	-	Is	C, G	-	4	About 700 ft E of Corrales Rd. and Meadowlark Lane.
5.412	R. F. Rapp	H. Sheets	1850	do.	4,988	100	12	Qal & QTs(?)	10.2	9- 5-56	do.	0	-	-	-	-	I	T, O	59	25	About 1,200 ft NW of a point on Corrales Rd., 0.8 mi. N of W end of bridge.
9.331	C. Sachechi	-	1951	do.	4,896	100	16	Qal & QTs(?)	7.3	8-21-56	do.	+4.0	900E	10- 2-56	-	-	Is	T, E	57	55	About 200 ft W of Rio Grande Blvd., 0.25 mi. SW of Corrales Rd. and Rio Grande Blvd. See analysis.

TABLE 3 (continued)

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Acres irrigated	Remarks
11.3.10.413	J. Torres	E. T. Hoard	1954	Valley floor	4,996	60	8	Qal	-	-	-	-	350E	9-13-56	-	-	Is	T, E	58	3	Driven well. About 600 ft S of Alameda Rd. and N.2nd St., 30 ft E of N. 2nd St.
10.431	C. Moore	V. Turner	1952	do.	4,996	70	8	Qal	-	-	-	-	450E	9-13-56	-	-	Is	T, E	58	10	About 1,200 ft S of Alameda Rd. and N. 2nd St., 30 ft E of N. 2nd St.
10.444	Nazareth Sanatorium	-	1954	do.	5,000	160	-	Qal(?) & QTs	-	-	-	-	500E	9-13-56	-	-	Is	T, E	58	-	About 300 ft S of Alameda Rd. and Edith Blvd. on W bank of Alameda lateral. See analysis.
11.334	do.	H. Sheets	1941	Brink of east mesa	5,070	-	-	QTs	-	-	-	-	-	-	-	-	I	T, E	-	4	Well is in small building NE of hospital.
15.112	E. Christ	A. Milligan	1952	Valley floor	4,994	65	16	Qal	7.7	9- 7-56	Hole in pump base	+2.4	800E	9- 7-56	-	-	Is	T, E	59	-	About 40 ft W of N. 4th St., 500 ft SW of Alameda Catholic Church.
16.312	Yonemoto Bros.	A. Sheeta	1954	do.	4,991	75	14	Qal	7.0	9-13-56	Top of slot in casing	0	-	-	-	-	Is	T, G	-	30	About 0.4 mi. NW of El Pueblo Rd. and N. 4th on E bank of Chamisal lateral.
17.413	-	A. Milligan	1951	do.	4,989	63	12	Qal	-	-	-	-	800R	-	-	-	Is	T, E	-	10	About 1,000 ft due W of El Pueblo Rd. and Rio Grande Blvd. on E bank of Albuquerque Main Canal.
18.414	United Pueblos Agency	Turner Drilling Co.	1951	do.	4,990	74	16	Qal	8.0	12- 6-56	Top of casing	+ .6	1350R	-	-	-	I	T, G	-	84	In field about 0.6 mi. NE of farm headquarters.
19.121	do.	-	1951	do.	4,990	78	16	Qal	15.1	12- 6-56	Hole in pump base	+1.2	1350R	-	-	-	Is	T, E	-	84	About 100 ft NW of farm headquarters.
19.313	J. McKinley	-	-	Edge of valley floor	4,995	68	4	Qal	-	-	-	-	-	-	-	-	I	T, E	-	-	In deep pit NW of farmhouse.
26.342	A. G. Simms	J. J. Merryfield	1951	Slope	5,157	302	16	QTs	183.8	11-20-56	Hole in pump base	+1.0	1250R	8-22-56	17M	1,440	I, O	T, Gn	61	160	About 0.4 mi. W of N.M.Hy.422 at Bear Canyon Arroyo. See analysis.
27.321	M. A. Woods	-	1943	Alluvial fan	5,034	170	12	QTs	60.6	8-14-56	Top of casing	+ .6	-	-	-	-	I, O	T, G	-	-	About 0.3 mi. E of Edith Blvd. on S side of Bear Canyon Rd.
29.121	A. O. Simms	J. J. Merryfield	1951	Valley floor	4,880	90	16	Qal & QTs(?)	-	-	Bottom of slot in casing	+ .4	1300R	-	-	-	Is	T, E	58	-	About 0.25 mi. N of Chavez Rd. on E bank of Pueblo lateral. Pumping level 32.8 ft Aug. 22, 1956.
28.212	W. P. Cutter	-	1952	do.	4,982	63	14	Qal	-	-	-	-	500R	-	-	-	Is	T, E	-	20	About 500 ft SW of Guadalupe Trail and Green Valley Rd.
28.341	A. G. Simms	E. T. Hoard	1951	do.	4,976	100	16	Qal & QTs(?)	-	-	-	-	1900R	-	-	-	Is	T, E	-	-	About 0.3 mi. S6 of Alvarado School on S bank of Gallegos lateral.
30.233	do.	do.	1951	do.	4,877	110	16	Qal & QTs(?)	8.8	8-22-56	Bottom of slot in casing	+2.0	-	-	-	-	Is	N	-	-	About 0.3 mi. N of Rio Grande Blvd. and Eakes Rd. on E bank of Griegos lateral.
30.341	do.	do.	1955	do.	4,974	110	16	Qal & QTs(?)	-	-	-	-	1200R	-	-	-	Is	T, G	58	-	About 0.25 mi. SW of Rio Grande Blvd. and Eakes Rd. on W bank of Griegos lateral. See analysis.

TABLE 3 (continued)

SANDOVAL COUNTY

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Acres irrigated	Remarks
12.3.12.213	Sandia Pueblo	-	-	Valley floor	5,035	-	16	Qal & QTs(?)	6.7	8-29-56	Bottom of slot in casing	+0.4	-	-	-	-	Is	T, E	-	-	About 0.6 mi. W of Corrales and Albuquerque Main Canals on SW edge of large earthen tank. S side of Corrales Canal.
14.311	J. F. Koontz	A. Sheets	1953	do.	5,025	65	8	Qal	-	-	-	-	800R	-	-	-	Is	C, G	-	-	About 1,200 ft SE of Corrales Rd. and Corrales Main Canal, 600 ft N of Corrales Rd.
14.332	A. L. Beal	A. L. Beal	1956	do.	5,023	27	6	Qal	-	-	-	-	800R	-	-	-	Is	C, G	-	10	Driven well. About 0.5 mi. N of Sandoval lateral, 200 ft E of Corrales Rd.
14.332a	do.	do.	1955	do.	5,023	37	4	Qal	9.3	9-12-56	Bottom edge of elbow	+1.4	300R	-	-	-	Is	N	-	-	Driven well. About 0.5 mi. N of Sandoval lateral, 100 ft E of Corrales Rd.
22.232	Mrs. Engle		1942	Alluvial fan	5,056	84	14	Qal	34.1	10-16-56	Top of casing	+3.5	1200R	-	5R	6R	O, N	N	-	-	About 2,100 ft NW of Corrales Main Canal at take-off point of Sandoval lateral. Once irrigated 100 acres.
23.113	B. Brown	A. Sheets	1951	Valley floor	5,025	50	6	Qal	-	-	-	-	600R	-	-	-	Is	C, G	-	15	About 700 ft N of Sandoval lateral on E bank of Corrales Main Canal.
23.333	E. Alary	H. Sheets	1951	do.	5,024	84	12	Qal	-	-	-	-	1000R	-	-	-	Is	T, G	-	30	About 0.3 mi. NW of Corrales Rd. at entrance drive to Sandia View Academy, on E bank of Corrales lateral.
26.112	Sandia View Academy	A. Sheets	1954	do.	5,018	45	8	Qal	5.3	9-11-56	Bottom edge of elbow	+1.3	750R	-	-	-	Is	C, G	-	-	About 150 ft E of Corrales Rd. opposite entrance drive to Sandia View Academy. See analysis.
26.112a	do.	do.	1953	do.	5,018	45	6	Qal	-	-	-	-	250R	-	-	-	Is	C, G	-	-	About 10 ft E of Corrales Rd. opposite entrance drive to Sandia View Academy.
26.142	do.	do.	1953	do.	5,017	45	6	Qal	-	-	-	-	-	-	-	-	Is	N	-	-	About 0.4 mi. SE of Corrales Rd. at entry drive to Sandia View Academy.
26.213	J. Alary	J. Alary	1955	do.	5,018	26	6	Qal	-	-	-	-	400R	-	-	-	Is	C, G	-	-	Driven well. About 0.4 mi. E of Corrales Rd. at entry drive to Sandia View Academy.
26.433	V. F. Curtis	V. F. Curtis	1956	do.	5,014	25	8	Qal	-	-	-	-	-	-	-	-	Is	C, G	-	-	Driven well. About 0.8 mi. SE of Sandoval Rd. from a point 0.9 mi. N of school on W side of Sandoval lateral.
27.222a	Sandia View Academy	A. Sheets	1953	do.	5,024	45	6	Qal	-	-	-	-	-	-	-	-	Is	N	59	-	About 0.2 mi. W of Corrales Rd. at entry drive to Sandia View Academy on E bank of Corrales lateral.
27.422	V. F. Curtis	V. F. Curtis	1953	do.	5,015	25	5	Qal	-	-	-	-	800E	9-12-56	-	-	Is	C, G	-	-	Driven well. About 0.9 mi. N of school, 200 ft E of Corrales Rd. Two 3-in. and two 5-in. casings.
33.424	J. F. Stueckal	-	-	do.	5,006	-	-	Qal(?)	-	-	-	-	400E	9-12-56	-	-	Is	C, G	-	-	About 0.3 mi. due N of Corrales Rd. at Meadowlark Lane.
33.433	E. Christ	E. T. Hoard	1955	do.	5,002	80	16	Qal	8.2	9- 6-56	Hole in pump base	+1.2	1400R	-	-	-	Is	T, G	-	-	About 800 ft NW of Corrales Rd. 100 ft N of County line, on W bank of Corrales lateral.
33.433a	A. E. Rollason	H. Sheets	1951	do.	5,003	-	16	Qal(?)	6.6	9- 6-56	Top of slot in casing	0	650R	-	-	-	Is	T, G	-	-	About 1,200 ft NW of Corrales Rd., 500 ft N of County line, on W bank of Corrales lateral.
34.343	L. J. Rutherford	-	-	do.	5,005	21	4	Qal	-	-	-	-	800R	-	-	-	Is	C, G	-	-	Driven well. About 1,100 ft SE of a point on Corrales Rd. which is 0.3 mi. NE of Meadowlark Lane. Two 4-in. casings.
35.313	P. Millar	A. Milligan	1954	do.	5,008	47	12	Qal	-	-	-	-	450R	-	-	-	Is	C, G	-	18	About 0.6 mi. SE of a point on Corrales Rd. which is 0.2 mi. S of school

TABLE 3 (continued)

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Acres irrigated	Remarks
12.4. 6.313	Sandia Pueblo	-	1951	Valley floor	5,040	-	-	Qal & QTs(?)	9.0	8-29-56	Hole in pump base	+1.0	-	-	-	-	Is	T	-	-	About 0.8 mile westerly from U. S. 85 at RR spur crossing S side of Bernalillo.
13.3.36.224	L. Montoya	A. Milligan	1951	do.	5,053	40	8	Qal(?)	8.6	9-14-56	Top of casing	+1.2	-	-	-	-	Ia	T	-	6	About 0.7 mi. SW of W end of N.M. 44 bridge over Rio Grande.
36.241	N. Mora	do.	1954	do.	5,053	40	8	Qal(?)	-	-	-	-	-	-	-	-	Ia	C, G	-	10	About 0.8 mi. SW of W end of N.M. 44 bridge over Rio Grande.
13.4.31.131	L. Montoya	do.	1955	do.	5,052	40	8	Qal	6.0	9-14-56	Top of casing	+ .9	-	-	-	-	Is	C, G	-	7	About 0.6 mi. SW of W end of N.M. 44 bridge over Rio Grande.
32.133	The Christian Brothers	-	1953	do.	5,055	140	16	Qal & QTs(?)	11.4	8-29-56	Hole in pump base	+1.6	-	-	-	-	Is	T	-	-	About 75 ft W of U.S. 85, 0.4 mi. S of N.M. 44.
32.211	L. Gross	A. Milligan	1954	Slope	5,080	110	16	Qal(?)	28.2	9-14-56	do.	+3.0	1,200R	9-14-56	31M	-	I	T, G	-	40	About 400 ft N of N.M. 44 overpass over A.T. & S.F. RR tracks.

* Pumped into public canal.

RECORDS OF SELECTED DOMESTIC AND STOCK WELLS AND SPRINGS IN THE ALBUQUERQUE AREA, BERNALILLO AND SANDOVAL COUNTIES, N. MEX.

Location number: Designates well and its location. (See well-numbering system.) S preceding number indicates spring.

Altitudes of wells listed are estimated from topographic maps; altitudes above sea level (ft).

Type of well: All wells listed are drilled unless otherwise noted in remarks.

Depth of well and water level: Measured depths are given in tenths of a foot; reported depths are given in feet.

Principal water-bearing bed: Qal, Alluvium, gravel and sand; QTs, Santa Fe group, gravel and sand; Km, Mancos shale, sandstone; p€, Precambrian weathered granite.

Yield and drawdown: E, estimated; M, measured; R, reported.

Use of water: D, domestic; I, irrigation; In, industrial; N, none; O, observation; P, other than municipal; S, stock.

Method of lift: C, centrifugal pump; Cy, cylinder pump; J, jet pump; N, no pump; T, turbine pump; Ts, submersible pump; E, electric; G, gasoline; H, hand; W, wind.

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Remarks
8.1W.14.333	Isleta Pueblo	H. Caraway	1957	West mesa	5,665	-	-	QTs	-	-	-	-	-	-	-	-	S	Cy, W	-	-
24.312	do.	-	-	Edge of lava	5,504	695	6	QTs	661.5	8- 5-56	Top of casing cover	+0.7	4R	-	-	-	S	Cy, W	71	See analysis.
8.2W.12.111	Laguna Pueblo	-	-	Valley floor	5,184	-	6	Qal(?)	139.0	4-28-57	do.	+ .5	4E	4-28-57	-	-	S	Cy, W	82	Do.
21.131	Isleta Pueblo	Bureau of Indian Affairs	-	do.	5,143	271	6	QTs	126.8	6- 5-56	Top of clamp on pump column	+ .9	9R	-	-	-	S	Cy, W	64	Do.
24.133	do.	do.	1834	do.	5,142	155	7	QTs(?)	136	-	-	-	10R	-	-	-	S	Cy, W	-	Destroyed prior to 1855.
38.343	do.	do.	-	do.	5,125	-	6	QTs(?)	138.6	8- 5-56	Top of casing cover	+1.1	-	-	-	-	S	Cy, W	-	-
9.1W. 3.112	Eli Sanchez	-	-	do.	5,290	99.8	8	Qal(?)	75.4	4-19-57	Top of casing	+ .5	-	-	-	-	N	N	-	-
4.424	G. T. Bill	B. Sheets	-	do.	5,280	157	6	Qal(?)	75	-	-	-	150E	4-18-57	21E	-	O, S	T, G	60	Pumping lift 4-19-57, 98.0 ft. See log. See analysis.
4.432	Donahue	-	-	Rio Puerco valley	6,281	-	6	Qal	81.86	2- 56	Top of casing	+ .6	-	-	-	-	6, O	Cy, W	-	-
10.114	A. A. Archulete	-	-	do.	5,277	319	6	QTs	-	-	-	-	-	-	-	-	S	Cy, W	64	See analysis.
14.134	do.	-	-	Terrace	5,323	290.0	8	QTs	187.1	10-26-56	Top of casing	0	5E	-	-	-	6	Cy, G	-	-
10.1W.23.314	D. D. Armijo	-	-	do.	5,380	-	-	QTs	-	-	-	-	-	-	-	-	S	Cy, W	-	-
11.1W. 9.412	S. Angell	-	-	Valley floor	5,468	185	6	Qal or QTs(?)	-	-	-	-	-	-	-	-	S	Cy, W	-	-
11.424	do.	H. Sheets	1949	do.	5,607	282	6	QTs	202R	-	-	-	2E	4-23-57	-	-	S	Cy, G	85	See analysis.
27.314	Benavidez Ranch	-	-	do.	5,387	110	8	Qal(?)	-	-	-	-	-	-	-	-	S	Cy, W	-	-
28.224	S. Angell	-	-	do.	5,390	96.0	8	Qal(?)	81.0	4-23-57	Top of casing	0	2E	-	-	-	S	Cy, W	55	See analysis.
12.1W. 8.132	Laguna Pueblo	Bureau of Indian Affairs	1844	do.	5,534	312	8	Kr	70	-	-	-	20R	11- 44	-	-	S	Cy, W	-	-
14.114	F. Bond and Son, Inc.	-	-	Arroyo floor	5,707	97.0	8	Qal(?)	73.7	4-24-57	Top of casing cover	+1.0	3E	-	-	-	S	Cy, W	66	See analysis.
35.234	Benavidez Ranch	-	-	Valley floor	5,628	-	5	QTs(?)	-	-	-	-	4E	4-23-57	-	-	S	Cy, W	66	Do.
13.1W.22.421	F. Bond and Son, Inc.	R. O. Smith	1856	do.	5,780	238	6	Qal	50	-	-	-	.5R	-	-	-	S	Cy, W	-	Depth of alluvium 50 ft. See analysis.
8. 1. 1.342	Isleta Pueblo	B. Caraway	1956	West mesa	5,273	430	8	QTs	385.3	1-16-57	Top of casing cover	+ .6	12R	-	-	-	S	Cy, W	68	See log. See analysis.
21.431	do.	J. Turner	1934	do.	5,471	612	6	QTs	588	11- 34	-	-	8R	-	-	-	S	Cy, W	-	-
8. 2.13.331	do.	-	-	Valley floor	4,990	23.2	1½	Qal	5.4	7- 6-56	Valve seat in pump base	+1.0	-	-	-	-	O	N	-	Driven well.
23.311	do.	-	-	West slope of valley	4,970	290.0?	-	QTs(?)	-	-	-	-	-	-	-	-	P	E	-	Supply for Isleta Pueblo and 3 mi. N.
24.133	do.	-	-	Low hill on valley floor	4,900	-	6	Qal(?)	-	-	-	-	-	-	-	-	P	Cy, W	-	Do.
27.432	do.	-	-	Slope from west mesa	4,880	-	6	QTs	15.5	1-15-57	Top of casing	+ .5	9E	-	-	-	S	Cy, W	-	-
29.213	do.	D. L. Miller	1816	West mesa	5,016	179	6	QTs	145.2	6- 4-56	do.	+3.5	3E	-	-	-	S	Cy, W	66	See analysis.
8. 3.14.231	do.	J. Turner	-	do.	5,221	312	6	QTs	284.8	2-15-56	Top of casing cover	+ .1	10R	-	-	-	S	Cy, W	72	Do.
8. 4. 9.314	do.	-	-	East mesa	5,341	-	-	QTs(?)	-	-	-	-	3E	2-27-58	-	-	S	-	56	Hubble Spring, see analysis.
8. 1.25.241	B. McLaughlin	-	-	West mesa	5,390	-	8	QTs	533.0?	1-16-57	Top of casing	+1.0	-	-	-	-	N	N	-	-
8. 2. 3.342	E. Snipes	-	1946	Terrace	4,983	140	3	QTs(?)	70	-	-	-	8E	10- 2-58	-	-	D	J, E	68	See analysis.
3.411	N. Whiting	-	1946	do.	4,990	92	8	QTs	70.2	10- 9-56	Top of casing cover	+2.0	-	-	-	-	S, O	Cy, W	66	-
11.244	J. L. Ross	-	-	Valley floor	4,928	-	12	Qal(?)	7.7	10- 8-56	Top of casing	+2.4	-	-	-	-	O	N	-	-
23.32[illegible]	O. A. Beck	-	1955	do.	4,915	27	3	Qal	8.9	10- 9-56	do.	+1.0	-	-	-	-	O	N	-	Driven well.
8. 3.11.330	J. Carter	-	-	Tijeres Arroyo	5,140	200	6	QTs(?)	140	-	-	-	-	-	-	-	D, S	Cy, E	-	-

TABLE 4 (continued)

Location	Owner or name	Driller	Year completed	Topographic situation	Alt.	Depth of well	Diameter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measurement	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measurement	Drawdown: Amount (ft)	Drawdown: Duration of test (hr)	Use of water	Method of lift	Temperature °F	Remarks
9. 3.17.231	J. Carter	-	-	Alluvial fan	4,995	125	-	QTs	73	-	-	-	-	-	-	-	D	Cy, G	-	-
18.414	J. Hine	-	-	do.	-	71.3	4	Qal(?)	35.7	8- 3-56	Top of casing	+2.0	-	-	-	-	O	N	-	-
36.211	Mrs. Lloyd	J. W. Bird	1917	East mesa	5,278	390	8	QTs	334.5	7- 1-41	Top of pipe clamp	+1.0	-	-	-	-	S	Cy, W	-	-
10.1.18.331	D. D. Armijo	-	-	Rio Puerco valley	5,590	275	6	QTs	-	-	-	-	8E	-	-	-	S	Cy, W	64	See analysis.
26.343	L. G. Hill	B. Sheets	1850	Valley floor	5,760	956	7	QTs	861	1954	-	-	-	-	-	-	D	Cy, E	-	-
10.2.14.123	F. B. Oldham	Gay Wood	1949	do.	5,085	154.0	5	QTs	148.2	1-31-57	Top of casing	+1.0	-	-	-	-	D, O	Cy, W	-	-
36.243	Martin Bros.	-	1950	do.	4,938	46	1.5	Qal	9.0	11-13-56	do.	+1.0	-	-	-	-	O	N	-	Driven well.
10.3. 1.114	Earl Montgomery	J. Wolking	1850	East mesa	5,215	309	7	QTs	258.1	1-26-56	do.	+1.0	-	-	-	-	D,S,O	Cy, W	-	-
2.111	L. Hilton	-	-	do.	5,130	180.0	6	QTs	158.7	1-26-56	do.	+2.0	-	-	-	-	D, S	Ts, E	-	-
2.121	L. D. Walrath	D. & H. Drilling Co.	1946	do.	5,140	235	4	QTs	-	-	-	-	-	-	-	-	D	Cy, E	-	-
3.144	H. A. Vaughn	-	-	do.	5,075	150	6	QTs	106.0	1-25-56	Top of casing	+1.0	-	-	-	-	D	Cy, E	-	-
3.222	Eugene Montgomery	J. Wolking	-	do.	5,110	219	6	QTs	140.3	1-26-56	do.	+2.0	18R	-	-	-	D, S	Ts, E	-	-
3.324	C. A. Boberschmidt	B. Sheets	-	do.	5,105	256	5	QTs	110	-	-	-	7R	-	-	-	D, S	Cy, E	-	-
3.412	F. Morgan	V. Turner	1943	do.	5,085	151	6	QTs	115.9	1-25-56	Top of casing	-5.0	5M	1-25-56	-	-	D, S	Cy, E	61	-
10.324	C. E. Buall	-	-	do.	5,135	180	6	QTs	171.6	1-24-56	do.	-1.0	-	-	-	-	D	Cy, E	-	-
10.422	J. Reay	-	-	do.	5,140	188.0	8	QTs	174.7	1-26-56	do.	+1.0	-	-	-	-	D	N	-	-
12.222	P. Butcher	E. B. White	-	do.	5,300	350.0	6	QTs	336.9	2-15-56	do.	+1.0	-	-	-	-	D, S	Cy, W	-	-
14.233	A. T. Smith	J. Wolking	-	do.	5,230	283.0	8	QTs	272.5	2- 6-56	do.	0	8R	-	-	-	D	J, E	-	-
14.441	D. W. Stiles	-	-	do.	5,240	284.0	7	QTs	279.0	2- 6-56	do.	-3.0	6R	-	-	-	D	Cy, W	-	-
10.4. 3.223	J. Judd	-	1849	do.	5,860	281	7	QTs	-	-	-	-	-	-	-	-	D, S	Cy, W	-	See analysis.
3.242	Guiterrez	-	1954	do.	5,850	320	8	QTs	255.4	1-26-56	Top of casing	+1.4	-	-	-	-	O	Cy, N	-	-
13.212	L. Petrino	-	-	Canyon floor	6,400	86.0	8	Qal(?)	48.5	1-24-56	do.	+5.0	10R	-	40R	4	N	N	-	-
S10.4.13.242	do.	-	-	do.	-	-	-	p€	-	-	-	-	50R	-	-	-	S	N	56	Embudo Spring. See analysis.
10.4.21.433	Mrs. F. N. Hicks	J. Turner	1941	East mesa	5,505	565	-	QTs	525	-	-	-	-	-	-	-	D	Cy, W	-	-
26.233	Wells Estate	Turner (?)	1940	Base of mountain	5,760	204.0	6	p€	66.1	2-14-56	Top of casing	-6.0	-	-	-	-	D, S	Cy, W	-	-
27.212	Cañon Lodge	H. Sheets	-	East mesa	5,625	685	6	QTs	650	-	-	-	-	-	-	-	D, P	Cy, E	-	-
27.244	Western Skies Hotel	Sheets (?)	-	do.	5,640	680.0	-	QTs	680+	-	-	-	-	-	-	-	N	N	-	Dry and caved at 680.0, 2-18-56. Well drilled 700 ft.
27.444	W. Johnson	A. Milligan	1950	Slope to Tijeras Canyon	5,565	350	6	QTs	325.5	1- 8-56	Top of casing	0	2.5R	-	-	-	D, S	Cy, E	-	-
35.231	F. Speakman	-	-	Base of mountain	5,840	80	6	p€	44.8	1- 7-56	do.	+1.0	.05R	-	-	-	N	N	-	-
35.342	do.	V. Turner	-	East mesa	5,850	105	6	p€	130	-	-	-	1R	-	-	-	D, S	Cy, W	-	-
11.1.26.424	F. Bond and Son, Inc.	B. Sheets	1947	West mesa	5,815	983	7	QTs	873	1947	-	-	-	-	-	-	S	Cy, G	-	See log. See analysis.
11.2. 7.241	A. J. Black	E. Hoard	-	do.	5,592	685	7	QTs	638.6	4- 6-56	Top of casing	0	-	-	-	-	S	Cy, G	-	-
12.144	do.	H. Sheets	1817	do.	5,242	400	8	QTs	287	-	-	-	20R	-	-	-	S	Cy, W	-	-
22.441	R. E. Hughes	V. Turner	1932	do.	5,197	240.0	6	QTs	228.6	4-25-57	Top of casing	+1.5	-	-	-	-	S	Cy, W	68	See analysis.
24.324	Mrs. Warren	N. H. Wade	1957	Terrace	5,125	184	6	QTs	153.6	4-25-57	Land surface	0	-	-	-	-	N	N	-	-
35.314	C. G. Shambaugh	E. Hoard	1954	do.	5,115	180	14	QTs	145	11-27-56	-	-	400R	-	15R	-	D	Cy, E	-	Drilled for irrigation
11.3.16.231	W. T. Stewart	-	-	Valley floor	4,895	60.0	16	Qal	6.2	8-21-56	Top of casing	+1.5	-	-	-	-	O	N	-	Destroyed in 1957.
27.231	S. A. Corley	H. Sheets	1946	East mesa	5,057	120	8	QTs	82.6	8-14-56	do.	+ .1	200R	-	-	-	D	T, E	-	Drilled for irrigation.
34.121	R. V. Dow	-	-	do.	5,025	-	-	QTs	63.5	8-14-56	Hole in pump base	0	-	-	-	-	D, S	T, E	-	-
35.343	D. B. Haynes	-	-	do.	5,135	255	5	QTs	180	-	-	-	-	-	-	-	D, I	T, E	-	-
S11.4. 1.314	U. S. Forest Service	-	-	Mountain slope	-	-	-	p€	-	-	-	-	-	-	-	-	-	-	63	La Cueva Spring. See analysis.
11.4.15.442	G. T. Lackey	-	-	East mesa	8,020	432	6	QTs	389.1	1-25-57	Tee on pump column	+4.0	-	-	-	-	O	Cy, N	-	-
18.341	J. Santillenes	M. H. Griffith	-	do.	5,673	750	6	QTs	683.5	2-19-57	Top of casing	+ .5	3E	-	-	-	S	Cy, G	68	See analysis.
30.422	A. Simms	-	-	do.	5,476	528.0	6	QTs	507.0	1-26-56	do.	+1.0	-	-	-	-	S	Cy, W	63	-
12.1.22.222	J. Baylor	-	-	West mesa	5,896	-	7	QTs	1,040	-	-	-	2E	-	-	-	S	Cy, G	71	See analysis.
12.2. 4.242	J. F. Koontz	-	-	do.	5,655	-	8	QTs	898.6	4- 8-56	Top of casing	+1.5	3E	-	-	-	S	Cy, W	74	Do.
18.413	do.	-	-	do.	5,786	-	8	QTs	890	-	-	-	-	-	-	-	S	Cy, G	67	-
26.122	J. Baylor	-	-	do.	5,482	-	-	QTs	525	-	-	-	-	-	-	-	S	Cy, W	-	-
12.3. 8.233	J. F. Koontz	-	-	do.	5,316	344.0	8	QTs	308.0	4- 4-56	Top of casing	+3.0	-	-	-	-	S	Cy, W	-	-

TABLE 4 (continued)

Location	Owner or name	Driller	Year com-pleted	Topo-graphic situation	Alt.	Depth of well	Diam-eter of well (in.)	Principal water bearing bed	Water level: Below land-surface datum	Water level: Date of measure-ment	Measuring point: Description	Measuring point: Distance above(+) or below (-) land surface (ft)	Yield: Rate (gpm)	Yield: Date of measure-ment	Drawdown: Amount (ft)	Drawdown: Dura-tion of test (hr)	Use of water	Method of lift	Tem-per-ature °F	Remarks
12.3.14.332b	A. L. Beal	A. L. Beal	1954	Valley floor	5,025	37	2½	Qal	8.1	10-16-56	End of pipe nipple	+1.2	-	-	-	-	O	N	-	Driven well.
26.112b	Sandia View Academy	-	-	do.	5,015	25	6	Qal	7	-	-	-	-	-	-	-	D	C, E	-	See analysis.
29.332	J. Baylor	-	-	West mesa	5,275	-	-	QTs	-	-	-	-	-	-	-	-	S	Cy, W	-	-
12.4.17.424	Sandia Pueblo	Bureau of Indian Affairs	-	East mesa	5,357	340	6	QTs	291.1	10-30-57	Top of casing cover	+2.0	-	-	-	-	S	Cy, W	68	See analysis.
30.124	do.	do.	1856	do.	5,190	203	6	QTs	165.0	11-25-58	Top of casing	+ .5	35R	-	-	-	S	Cy, W	63	Do.
32.242	do.	do.	-	do.	5,565	628	6	QTs	570.8	7- 8-59	do.	+1.0	-	-	-	-	S	Cy, W	65	See log. See analysis.
35.234	Mrs. Venegas	-	-	Base of mountain	6,880	172.5	5	p€	73.8	3-13-56	do.	+1.0	-	-	-	-	N	Cy, W	-	See analysis.
13.3. 3.223	Bureau of Land Management	M. R. Griffith	1957	Arroyo bank	5,280	183	8	QTs	140.5	8-19-57	Top of casing cover	+ .5	15R	3- 7-57	-	6	S	Cy, W	61	See log. See analysis.
20.434	F. Bond and Son, Inc.	R. D. Smith	1957	West mesa	5,510	480	9	QTs	437	-	-	-	-	-	-	-	S	Cy, W	-	-
25.244	Pilgrim Indian School	F. Honeycutt	1850	do.	5,145	119	6	QTs	102	-	-	-	40R	-	-	-	D, P	Te, E	-	See analysis.
13.4. 1.233	El Yeso Liquor Store	-	-	Valley floor	5,114	44	4	Qal	21.3	11-22-57	Top of pipe clamp	+1.0	-	-	-	-	D	Cy, H	-	Do.
1.432	Ben Meyers	-	-	Alluvial fan	5,120	80	4	Qal(?)	-	-	-	-	-	-	-	-	D	J, E	-	Do.
11.113	John Stone	J. Stone	1948	Valley floor	5,100	32	2	Qal	25	-	-	-	-	-	-	-	D	C, E	-	Do.
12.431	San Felipe Pueblo	-	-	Arroyo floor	5,250	185.0	6	QTs	162.4	10-30-56	Top of casing	+1.0	-	-	-	-	S	Cy, E	-	-
18.311	Santa Ana Pueblo	-	-	Slope from west mesa	5,285	-	5	QTs	191.7	1-25-57	Hole in casing cover	+1.0	-	-	-	-	D,S,O	Cy, W	-	-
19.334	H. L. Brooks	-	-	do.	5,145	160	6	QTs	108.3	3-28-56	Top of casing	-2.0	-	-	-	-	D	S, E	-	-
28.421	McDonald	-	-	Arroyo floor	5,210	160.0	5	QTs	146.8	10-18-56	do.	+1.5	-	-	-	-	S	Cy, W	71	-
30.231	Coronado State Monument	-	1840	Terrace	5,087	90	-	QTs	36	-	-	-	-	-	-	-	D, P	Cy, G	54	See analysis.
14.2. 5.320	Zia Pueblo	Bureau of Indian Affairs	1939	Arroyo floor	5,550	130	8	QTs	118	-	-	-	7	-	-	-	S	Cy, W	58	Do.
23.321	do.	do.	-	Valley	5,595	-	-	QTs	380.0	3-24-59	Top of pipe clamp	+2.0	-	-	-	-	S	Cy, W	-	Do.
14.3. 3.433	Santa Ana Pueblo	do.	1958	Slope from Santa Ana Mesa	5,725	637	7	QTs	580	8- 58	-	-	8R	-	-	-	S	Cy, W	-	-
6.423	Bureau of Land Management	-	-	Terrace	5,320	38.0	6	QTs	22.5	12-28-59	Top of casing	+1.0	-	-	-	-	S	Cy, W	-	-
18.340	Zia Pueblo	Bureau of Indian Affairs	-	do.	5,370	130	-	QTs	104.0	4-22-58	Top of pipe clamp	+1.5	-	-	-	-	S	Cy, W	-	-
22.323	Santa Ana Pueblo	do.	-	Riverbank	5,237	28.0	6	QTs	16.3	12-28-59	do.	+2.0	-	-	-	-	S	Cy, W	-	-

TABLE 5
LOGS OF REPRESENTATIVE WELLS AND TESTS IN THE ALBUQUERQUE AREA, BERNALILLO AND SANDOVAL COUNTIES, N. MEX.

Descriptions of materials penetrated and depths to strata indicated in the drillers' logs are copied from the originals; only the word order and punctuation have been altered. As a result the terms used to describe the rock materials do not necessarily have the same connotation in all logs and in some logs may have a distinctly different meaning because of different usage by different drillers. For example, the term "lime shell" or "shell" may mean a thin limestone or a fossiliferous zone or a bed which is harder to drill than the beds above or below. Rock may mean a boulder or a resistant bed. Where drillers' terms are believed to have been used in an unusual sense they are enclosed in quotation marks. The junior authors' comments are enclosed in brackets [].

Stratigraphic terms are inserted by the junior author on the basis of comparison of the log with the known sequence of rocks in the area.

	Thickness (feet)	Depth (feet)
Well 9.1W.4.424 Driller's log of domestic and stock well		
Alluvium:		
Shale, gray, soft, alternate streaks of hard, brittle clay	85	85
Sand, fine; contains gravel	12	97
Clay, gray, hard, brittle	11	108
Sand, light-brown, fine, tight; carries water	4	112
Sand and small gravel; drills tight, becomes loose at 115; yields water	7	119
Clay, gray, soft, streaks of blue sandy clay	19	138
Sand, gray, coarse, some gravel; yields water	14	152
Clay, gray, soft	5	157
Well 8.1.1.342 Sample log of stock well		
Santa Fe group:		
Sand and gravel; mostly medium and fine rounded quartz sand; silty; unconsolidated to weakly consolidated; very pale orange to pale-yellow brown; contains rounded granules and pebbles of quartz and igneous rocks	50	50
Sandstone, mostly medium- and fine-grained, quartzose, silty, rounded grains, friable, pale-yellow-brown; contains some conglomerate composed of rounded granules and small pebbles of quartz and igneous rock; contains some white carbonate material; the matrix of the rock is calcareous	50	100

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 8.1.1.342 (continued)		
Santa Fe group (continued)		
Sandstone, fine- to medium-grained, quartzose, rounded grains, gray-orange- to pale-yellow-brown; contains some rounded coarse quartz sand grains and granules and pebbles of igneous rock; contains some white carbonate material; the matrix of the rock is calcareous	10	110
Sandstone, very fine- to medium-grained, quartzose, silty, slightly arkosic, rounded grains, gray-orange; contains rounded coarse-grained quartz sand, very coarse-grained sand composed of igneous material, and igneous pebbles	50	160
Sandstone, medium- and coarse-grained, quartzose, silty, arkosic, calcareous cement, gray-orange; contains very fine to very coarse rounded quartz sand and quartzose and igneous pebbles	60	220
Same as 60-220, except more conglomeratic; contains some white carbonate rock	30	250
Sand and gravel; composed of rounded granules and pebbles of quartz, granite and other igneous rocks; slightly arkosic; contains magnetite	10	260
Sandstone, medium- and coarse-grained, quartzose, silty, slightly arkosic, rounded grains, calcareous cement, gray-orange; contains rounded gravel and pebbles of quartz and igneous rocks; contains some white to light-gray carbonate material and some magnetite; becomes finer grained toward the bottom of the interval	90	350
Sandstone, very fine- to medium-grained, quartzose, silty, calcareous cement, gray-orange; contains some rounded coarse sand to pebbles composed of quartz and igneous material; contains magnetite	20	370
No sample	20	390
Sandstone, very fine- and fine-grained, quartzose, silty, calcareous cement, gray-orange; contains some medium to coarse sand and a few granules of quartz and igneous materials; contains magnetite and some white to light-gray carbonate material	10	400
Sand and gravel; quartzose, slightly arkosic; rounded grains; contains some rounded granules and pebbles of quartz and igneous rocks; contains magnetite and some white carbonate material	30	430

TABLE 5 (continued)

Well 9.1.22.211 Driller's log of Norrins Realty Co. Fee No. 2 oil test

	Thickness (feet)	Depth (feet)
Santa Fe group:		
Topsoil	2	2
Gypsum and caliche	28	30
Sand, gray, soft	170	200
Clay, red	40	240
Gypsum [caliche?]	5	245
Sand	55	300
Shale, red, and "shells?"	125	425
Gypsum, hard [caliche?]	40	465
Clay with gypsum	85	550
Gypsum, hard [caliche?]	50	600
Sand, white, and sandstone	40	640
Gypsum and clay	160	800
Shale, red, yellow, and white	100	900
Gypsum and clay	125	1,025
Gypsum and red shale	75	1,100
Shale, red	40	1,140
Sand, coarse	60	1,200
Lime "shells" [caliche?]	10	1,210
Shale, red	30	1,240
Lime, gray	40	1,280
Sand, coarse	40	1,320
Sand, water-bearing	40	1,360
Lime "shells" [caliche?]	30	1,390
Shale, red	15	1,405
Sand, fine	55	1,460
Lime "shells" [caliche?]	15	1,475
Sand, coarse, and gravel	55	1,530
Sand, fine, soft	50	1,580
Sand, soft	60	1,640
Lime, hard	10	1,650
Sand, soft	110	1,760
Shale, gray	10	1,770
Sand, black	20	1,790
Lime, brown	20	1,810
Sand, gray	30	1,840
Shale, red, sandy	34	1,874
Sand, red	26	1,900
Gypsum rock [caliche?]	38	1,938
Sand, gray, coarse	46	1,984
Shale, gray	36	2,020
Sand, gray, fine	43	2,063
Shale, red, sticky	11	2,074
Gypsum rock [caliche?]	56	2,130
Shale, gray	83	2,213
Lava rock [basalt]	30	2,243

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 9.1.22.211 (continued)		
Santa Fe group (continued)		
Shale, gray	27	2,270
Sand, gray, and gravel	130	2,400
Sand, gray, fine	60	2,460
Shale, red, sticky	40	2,500
Gypsum rock [caliche?]	20	2,520
Shale, red, sandy	50	2,570
Shale, red, "lime shells"	35	2,605
Gravel, coarse	8	2,613
Lava flow [basalt]	19	2,632
Shale, dark-gray	23	2,655
Shale, red, sandy	70	2,725
Shale, red; contains hard layers of sand	55	2,780

Well 9.1.22.211a Driller's log of Norrins Realty Co.
Pajarito Grant No. 1 oil test

Santa Fe group:	2,997	2,997
Clay, sandy, hard	26	3,023
Clay, sandy, hard, and lime	11	3,034
Gravel or boulders, coarse, hard	3	3,037
Lava flow [basalt]	20	3,057
Lava flow with shale breaks	5	3,062
Shale, dark; shows little gas	5	3,067
Shale, dark	12	3,079
Shale, dark-blue	4	3,083
Clay, red, sandy	4	3,087
Clay, red, sandy, and gravel	20	3,107
Sand, loose	7	3,114
Sand, soft	5	3,119
Hard sand crust and sandstone	7	3,126
Clay, sandy, dry	12	3,138
Shale, red, sandy, dry	46	3,184
Sand and shale, red, dry	13	3,197
Shale, blue	12	3,209
Shale, blue gum and clay	18	3,227
Shale, blue, sandy	9	3,236
Shale, blue gum and clay	10	3,246
Shale, sandy	5	3,251
Sand and shale; a little gravel at bottom	13	3,264
Sand and gravel	8	3,272
Gravel, sandy	15	3,287
Clay, red, sticky	27	3,314
Sand formation, hard, black [basaltic pyroclastics?]	6	3,320
Sand, black, and dark-gray	2	3,322
Sand, dark-gray; show of oil	13	3,335

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 9.1.22.211a (continued)		
Santa Fe group (continued)		
Sand, black; shows a little gas and oil	4	3,339
Sand, gray; fresh-water	11	3,350
Sand, gray; water-bearing	7	3,357
Sand, and clay, blue	12	3,369
Clay, sandy, blue and brown	12	3,381
Sand and clay, gray	17	3,398
Sand, gray; water-bearing; small oil show ...	16	3,414
Sand, gray and black; water-bearing; small oil show	12	3,426
Shale, blue-gray, sandy	11	3,437
Clay, dark-red	15	3,452
Clay, red, sandy	6	3,458
Clay, dark-brown, streaks of gray sand	6	3,464
Sand, gray and black; oil showing on top of water	12	3,476
Sand, gray and black; slight oil show	7	3,483
Gumbo, dark-gray, sandy, shale or clay	8	3,491
Sand, light-red, fresh water	11	3,502
Sand, red	10	3,512
Clay, sandy	2	3,514
Clay, red	5	3,519
Sand, red	2	3,521
Clay, sandy	20	3,541
Sand, yellow, fine	30	3,571
Sand	17	3,588
Clay and sand	10	3,598
Sand, with fine gravel	9	3,607
Gravel, fine, sandy	32	3,639
Gravel, sandy, with gummy clay streaks	28	3,667
Sand, and clay	7	3,674
Gum shale and clay	19	3,693
Gum shale; little sand streaks and clay	26	3,719
Gum shale and clay	22	3,741
Shale, hard	11	3,752
Shale, hard, sand streaks	46	3,798
Shale, sandy, with streaks of white lime	23	3,821
Sand, hard	3	3,824
Sand, dark-gray with black streaks, hard; cored	2	3,826
Sand, hard	8	3,834
Sand, gray and brown; shows oil and water; cored	2	3,836
Sand, brown and gray, hard; show oil and water	15	3,851
Sand, hard	6	3,857
Gum shale and clay	107	3,964
Sand, hard	2	3,966

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 9.1.22.211a (continued)		
Santa Fe group (continued)		
Sand, very dark; full of water; smell of oil; cored	1	3,967
Sand, soft	15	3,982
Gum shale and clay	26	4,008
Gum shale, red, and clay	73	4,081
Shale, red, sandy	88	4,169
Gum shale, red, tough, and clay	13	4,182
Flow, hard, cemented lava [basalt]	8	4,190
Flow, black, hard, tough [basalt]	6	4,196
Shale, hard, dry	23	4,219
Gum shale and clay	12	4,231
Sand, hard, sharp [angular?]	26	4,257
Sand, hard	2	4,259
Sand, hard, sharp [angular?]	4	4,263
Sand, coarse to fine, hard	3	4,266
Sand, coarse, hard	9	4,275
Sand, red, hard, sharp [angular?]	11	4,286
Sand, hard, sharp [angular?]	7	4,293
Sand, coarse, hard	46	4,339
Shale, red	7	4,346
Shale, red, hard, dry	41	4,387
Shale, red	62	4,449
Shale, sandy	22	4,471
Sand rock, hard [sandstone]	8	4,479
Sand, red, and fine gravel	7	4,486
Sand and gravel	6	4,492
Sand, hard	20	4,512
Gum shale and clay	22	4,534
Shale, hard, dry	9	4,543
Hard shells [sandstone?]	18	4,561
Shale, sandy, hard	70	4,631
Shale, blue gum, and clay	77	4,708
Shale, red, sandy, hard	48	4,756
Sand, brown, hard	22	4,778
Sand, brown; water-bearing; shows some oil	28	4,806
Sand, brown; water-bearing	26	4,832
Sand, brown, and gravel	5	4,837
Shale, red gum, and clay	54	4,891
Shale, red, dry	15	4,906
[No report]	198	5,104

Well 9.2.12.322 Driller's log of public supply well

Alluvium:		
Soil, adobe	2	2
Sand, silty	5	7

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 9.2.12.322 (continued)		
Alluvium (continued)		
Sand and gravel	10	17
Sand, gray	1	18
Sand and gravel	9	27
Clay, dark-brown	2	29
Gravel, and sand, gray	6	35
Sand, gray	3	38
Gravel and sand	1	39
Clay, brown	2	41
Sand and gravel	1	42
Clay, gray	5	47
Gravel and sand	17	64
Sand, brown, slightly cemented	5	69
Clay, brown	9	78
Sand, brown, packed	5	83
Sand, brown, silty	7	90
Sand, cemented, clay conglomerate [?]	16	106
Sand, coarse, and pea gravel	2	108
Sand, brown, fine	6	114
Sand, brown, packed, cemented streaks	9	123
Santa Fe group:		
Clay, brown	4	127
Sand, brown, fine	10	137
Clay, brown, and streaks of brown sand	6	143
Sand, coarse	1	144
Clay, brown, and streaks of brown sand	42	186
Sandstone, brown, soft	3	189
Sand, brown, fine	3	192
Sand, brown	6	198
Clay, reddish-brown, sandy	5	203
Sand, brown	5	208
Clay, reddish-brown, sandy	3	211
Sand, brown	6	217
Conglomerate and gray clay	4	221
Sandstone, gray, hard	4	225
Conglomerate and sandy clay	4	229
Sand, brown	4	233
Clay, reddish-brown, sandy	8	241

Well 10.1.28.440 Driller's log F. H. Carpenter
Atrisco Grant No. 1 oil test

	Thickness (feet)	Depth (feet)
Santa Fe group:		
Soil, sandy	10	10
Sand and coarse gravel	310	320
Clay, red	30	350
Sand, red	30	380

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 10.1.28.440 (continued)		
Santa Fe group (continued)		
Clay and streaks of sand	40	420
Sand and streaks of red clay	450	870
Clay, brown, calcareous	40	910
Sand	120	1,030
Clay, brown	10	1,040
Sand, red	200	1,240
Clay, brown	20	1,260
Sand with a few brown clay streaks	290	1,550
Ash, black	20	1,570
Volcanics [probably basalt]	10	1,580
Sand, pink and red	100	1,680
Clay, brown	30	1,710
Sand	100	1,810
Clay, dark-brown	30	1,840
Sand, gray and some green	280	2,120
Shale, brown, hard	20	2,140
Sand, with "metamorphic rocks"	30	2,170
Shale, brown, hard, bentonitic	30	2,200
Sand, red and brown, calcareous	390	2,590
Shale, gray, top gray member [?]	20	2,610
Sand, with shale streaks	40	2,650
Sand, gray, fine	200	2,850
Sand, green, fine	60	2,910
Sand, gray, tightly cemented and calcareous	30	2,940
Sand, red, white, and blue	30	2,970
Sand, gray	30	3,000
Sand, with brown calcareous cement	50	3,050
Sand, gray, fine	70	3,120
Sand, green	20	3,140
Sand, gray; water-bearing	130	3,270
Shale, gray, bentonitic	20	3,290
Sand, soft; cored; fresh water	60	3,350
Hard igneous sill, black and crystalline [basalt flow]	90	3,440
Sand, soft; water-bearing	85	3,525
Clay, red, with jasper gravel	5	3,530
Sand	45	3,575
Lime shell, white, chalky [probably caliche]	5	3,580
Sand, green	70	3,650
Shale, gray, "conglomerated" [?] and dense	225	3,875
Sand, soft, calcareous	80	3,955
Shale, gray, bentonitic	35	3,990
Sand, with streaks of red shale	50	4,040
Shale, red, with trace of sand	60	4,100
Sand, gray	30	4,130
"Igneous sill," black, hard [basalt flow]	5	4,135
Sand, gray	15	4,150

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 10.1.28.440 (continued)		
Santa Fe group (continued)		
Shale, gray, bentonitic, dense	25	4,175
Sand, white, rounded 1/32- to 1/8-inch grain	75	4,250
Shale, red and gray	15	4,265
Sand, white, rounded 1/32- to 1/8-inch grain	125	4,390
Shale, blue	20	4,410
Sand, white	10	4,420
Shale, blue	15	4,435
Sand, white	25	4,460
Shale, blue	10	4,470
Sand, with streaks of shale	85	4,555
"Igneous sill" [basalt flow]	5	4,560
Sand, gray, soft	15	4,575
Hard "igneous sill," black [basalt flow]	15	4,590
Shale, red and gray	20	4,610
Sand, soft, rounded 1/32-inch grain	170	4,780
Shale	10	4,790
Sand, rounded	115	4,905
"Igneous sill," black, hard [basalt flow] ...	35	4,940
Sand	5	4,945
Shale, green	5	4,950
Shale, pink	15	4,965
"Igneous sill," hard [basalt flow]	10	4,975
Shale	15	4,990
Lime, white [caliche?]	5	4,995
Shale, conglomerated[?], streaks of sand	185	5,180
Sand, rounded 1/32- to 1/16-inch grain	290	5,470
Sand, black, with thin igneous streaks	20	5,490
"Igneous sill," hard, trace of calcite [basalt flow]	65	5,555
"Igneous, calcite," soluble [ash or caliche?]	45	5,600
"Igneous sill," gray [basalt flow]	48	5,648
"Igneous shale," gray with sand streaks [probably tuff]	157	5,805
Sand, white, soft, calcareous	235	6,040
"Igneous sill," black, very hard [basalt flow]	55	6,095
Sand	5	6,100
Cretaceous(?):		
Shale, conglomerated[?], gray sand stringers	95	6,195
Sand, hard, iron pyrites, trace of green shale	85	6,280
Bentonite, with sand, green; red and gray shale	50	6,330
"Igneous sill," black [basalt flow]	5	6,335
Shale, red and gray with sand and igneous shells[?]	55	6,390
Shale, red, with gray stringers, top of red beds	130	6,520

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 10.1.28.440 (continued)		
Cretaceous(?) (continued)		
Sand, white, fine	5	6,525
Shale, red, hard	50	6,575
Sand, white	10	6,585
Shale, red	10	6,595
Sand, white	20	6,615
Shale, red, hard	37	6,652

Well 10.1.30.220 Driller's log of domestic and industrial well

	Thickness (feet)	Depth (feet)
Alluvium:		
Sand	4	4
Clay	2	6
Santa Fe group:		
Caliche	5	11
Sand and gravel	104	115
Clay	10	125
Sand and gravel	15	140
Clay, sand, and gravel	80	220
Sand and gravel	15	235
Clay and gravel	37	272
Clay, red	23	295
Clay, gravel, and caliche	55	350
Sand and boulders; hard	42	392
Clay, red, and caliche	43	435
Shale, and layers of sand	11	446
Shale, hard	6	452
Sand	40	492
Clay	32	524
Sand, clay, and gravel	23	547
Sand, hard	26	573
Sand, hard, and caliche	27	600
Clay, red	21	621
Sand, hard	12	633
Clay, hard	32	665
Clay, red, sandy	37	702
Sand and clay layers	31	733
Clay, sandy	4	737
Sand, broken	25	762
Conglomerate, black, hard	43	805
Sand, hard, gravel and clay breaks	35	840
Clay, sandy	32	872
Sand, broken	18	890
Shale, hard, sandy	10	900
Sand and clay layers	33	933
Clay, sandy	26	959
Clay, red, with gravel	44	1,003

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 10.1.30.220 (continued)		
Santa Fe group (continued)		
Clay with layers of sand	44	1,047
Clay, sticky	40	1,087
Clay, sandy	15	1,102
Sand and layers of clay	16	1,118
Clay, sandy	30	1,148
Clay and layers of sand	7	1,155
Clay and sandy clay	31	1,186
Sand, hard, and layers of clay	23	1,209
Clay, sandy	46	1,255
Clay and layers of sand	50	1,305
Clay, red and green	23	1,328
Clay with layers of sand	18	1,346
Shale, hard	25	1,371
Rock, hard; cut bit	15	1,386

Well 10.3.7.441b Driller's log of industrial well

Alluvium:		
Soil and sand	9	9
Sand, gray, fine; water at 14 feet	20	29
Sand, gray, coarse	12	41
Gravel, heavy	31	72
Gravel, cemented	15	87
Clay, brown, sandy	8	95
Sand, gray, coarse	20	115
Clay, sandy	12	127
Santa Fe group:		
Sand and clay streaks, brown	48	175
Clay, red	5	180
Sand, brown	2	182
Sand, slate-gray	4	186
Sand, brown	8	194
Sandstone, brown, hard	4	198
Conglomerate, packed sand, red clay, and boulders, grading into brown sandy clay and boulders	45	243
Sand, gray, coarse	4	247
Clay, brown, sand streaks	36	283
Conglomerate, brown clay, and silt	27	310
Sand, coarse, and pea gravel, gray	28	338
Sand and clay streaks, brown	10	348
Sand, gray, coarse	27	375
Conglomerate, red sand, and clay	8	383
Sand, gray, coarse	13	396
Sandstone, brown, soft	7	403
Clay, red, dense, sticky	2	405

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 10.3.7.441b (continued)		
Santa Fe group (continued)		
Clay, brown, sandy	21	426
Clay, red, sticky	14	440
Sand, red, coarse	21	461
Clay, red	6	467
Sand, gray	3	470
Sand, brown, tight	58	528
Sand and pea gravel	2	530
Clay, brown, sandy	6	536
Clay, brown	4	540
Sand, brown	6	546
Clay, brown, sandy	3	549
Sand, brown, coarse	13	562
Clay, brown, sandy	3	565
Sand, brown	10	575
Clay, brown, sandy	2	577
Sand, brown	5	582
Clay, brown, sticky	2	584
Sand, brown, fine	21	605
Clay, brown, sandy, hard	15	620
Clay, pink	6	626
Sand, brown, coarse	44	670
Sand and gravel, gray, hard, cemented	3	673
Conglomerate, red clay, brown silt, and sand	24	697
Clay, red, sticky	11	708
Sand, brown, fine, silty	6	714
Clay, red, sticky	9	723

Well 10.3.20.141 Driller's log of industrial well

	Thickness (feet)	Depth (feet)
Alluvium:		
Top soil	5	5
Sand	24	29
Sand and gravel	3	32
Sand	3	35
Gravel and boulders	18	53
Sand and gravel	3	56
Gravel	15	71
Clay and boulders	3	74
Shale and clay, very hard	3	77
Shale, clay, and hard lime	6	83
Shale and clay	9	92
Rock	6	98
Shale, lime, and sandstone	18	116
Santa Fe group:		
Sand	15	131
Sand and clay streaks	3	134

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 10.3.20.141 (continued)		
Santa Fe group (continued)		
Sand	3	137
Gravel and sand	28	165
Sand and clay streaks	5	170
Sand and gravel	23	193
Sand	67	260
Clay, sandy	5	265

Well 10.3.36.132 Sample log at site of hospital well

	Thickness (feet)	Depth (feet)
Santa Fe group:		
Gravel and sand; undifferentiated	330	330
Gravel, clean	10	340
Gravel, clean, subrounded to subangular	10	350
Gravel	20	370
Gravel; contains some very coarse sand	10	380
Gravel	60	440
Gravel, clean; contains silt beds	10	450
Gravel	90	540
Sand, fine to very coarse, angular	10	550
Sand, fine to very coarse, and gravel, angular	10	560
Sand, fine to very coarse; contains some pebbles	20	580
Sand, fine to coarse	10	590
Sand, medium to coarse	10	600
Sand, medium to very coarse	10	610
Sand, fine to very coarse, poorly sorted	40	650
Sand, fine to very coarse, poorly sorted, but generally finer than from 10 to 650 feet	20	670
Sand, fine to coarse, poorly sorted	20	690
Sand, fine to medium, better sorted than from 670 to 690 feet	20	710
Sand, fine to coarse; contains a few pebbles	10	720
Sand, fine to medium	20	740
Sand, very fine to medium	10	750
Sand, very fine to fine	50	800
Sand, very fine to medium	40	840
Sand, fine to coarse	40	880
Sand, fine to coarse; contains a few pebbles	10	890
Sand, fine to very coarse	20	910
Sand, fine to coarse	30	940
Sand, fine to medium	10	950
Sand, fine to coarse	60	1,010
Sand, very fine to coarse	10	1,020

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 10.4.16.334 Driller's log of municipally owned public-supply well		
Bajada deposits and Santa Fe group:		
Top soil	5	5
Caliche	2	7
Sand and gravel	54	61
Clay, sandy, gravel, and rocks	19	80
Clay	50	130
Clay, sandy, and rock	120	250
Clay, sandy	14	264
Clay, sandy, and rock	41	305
Clay with coarse sand	28	333
Clay, sandy	4	337
Clay with coarse sand	18	355
Clay, sandy, and gravel	11	366
Clay with coarse sand	14	380
Clay, sandy, and gravel	20	400
Clay, sandy	60	460
Santa Fe group:		
Sand, coarse, and gravel	19	479
Clay, sandy	78	557
Sand and gravel	23	580
Clay with coarse sand	23	603
Clay	12	615
Clay with coarse sand	39	654
Sand, hard	16	670
Sand and gravel	5	675
Clay	27	702
Sand, hard	19	721
Clay	21	742
Sand, hard	2	744
Clay	5	749
Sand, hard	2	751
Clay	27	778
Clay, sandy, and gravel	33	811
Clay	49	860
Clay with coarse sand and small gravel	10	870
Clay	13	883
Clay with coarse sand and gravel	11	894
Clay	13	907
Sand and gravel, hard	24	931
Clay, gray, sandy, and boulders	37	968
Clay with fine sand; gray	36	1,004
Clay, red, sandy, and boulders	20	1,024
Sand, coarse, and gravel; contains clay streaks	34	1,058
Sand, coarse, and streaks of clay	14	1,072

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 10.4.16.334 (continued)		
Santa Fe group (continued)		
Sand, coarse	11	1,083
Clay	7	1,090
Clay, sandy	24	1,114
Clay	30	1,144
Clay, sandy	2	1,146
Clay	24	1,170

Well 11.1.26.424 Driller's log of stock well

	Thickness (feet)	Depth (feet)
Santa Fe group:		
Sand and streaks of small gravel	218	218
Sandstone, soft, and conglomerate	13	231
Sand, "heavy"[?], streaks of pea gravel, and a few thin streaks of clay	279	510
Clay, reddish, sandy, some clay	246	756
Clay, cream-colored or yellow, sticky	34	790
Clay, yellow, sandy	45	835
Clay, sandy	27	862
Clay, sandy, soft; water was encountered in this formation, but drilling operations obscured it until a depth of 900 feet was reached and the hole collapsed. After the hole was cased to 880 feet, cleaning out operations revealed the water	40	902
Clay, yellow, dense and sticky	4	906
Sand, gray, fine, clean; grades into coarse sand toward bottom of strata; heaved on test; water	13	919
Sand, coarse, some pea gravel; water	4	923
Sandstone, gray, hard; gave trouble setting screen	6	929
Sand, gray, coarse; water	4	933
Clay, sandy, and pink and brown sand	19	952
Clay, pink	8	960
Clay, brown, sandy	19	979
Clay, brown, dense, sticky	4	983

Well 11.3.23.121 Driller's log at site of industrial well

	Thickness (feet)	Depth (feet)
Bajada deposits:		
Soil	2	2
Caliche	10	12
Clay	6	18
Sand and gravel	4	22
Clay	2	24

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 11.3.23.121 (continued)		
Santa Fe group:		
Sand and gravel, large gravel	6	30
Sand and gravel, hard	5	35
Sand and gravel	5	40
Sand and gravel, hard	16	56
Sand and clay	9	65
Clay	1	66
Sand and gravel, hard streaks	9	75
Sand and gravel, large gravel	5	80
Sand and gravel, cemented	10	90
Sand and gravel	10	100
Sand and clay	5	105
Sand and gravel, soft	15	120
Clay	14	134
Sand and gravel	6	140
Sand and gravel, clay stringers	5	145
Sand and gravel, hard stringers	10	155
Sand and gravel, soft	5	160
Clay, hard	16	176
Sand and gravel, soft	4	180
Clay, hard	13	193
Sand and gravel, soft	12	205
Sand and gravel	10	215
Clay, streaks of sand and gravel	15	230
Sand and gravel	5	235
Sand and gravel, clay streaks	24	259
Clay, soft	3	262
Sand and gravel, clay streaks	13	275
Sand and gravel, hard	5	280
Sand and gravel, soft	2	282
Sand and gravel, hard; some clay	6	288
Sand and gravel, soft	2	290
Sand and gravel, clay streaks	20	310
Sand and gravel	17	327
Sand, gravel, and clay	3	330
Sand and gravel	15	345
Sand and gravel, hard clay streaks	5	350
Clay, gravel stringers	8	358
Sand and gravel, soft	4	362
Sand and gravel, clay streaks	5	367
Clay	8	375
Clay, gravel stringers	5	380
Clay	3	383
Sand, gravel, and some clay	7	390
Sand and gravel, soft	5	395
Sand, gravel, and clay	5	400

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 11.3.23.121 (continued)		
Santa Fe group (continued)		
Clay	3	403
Sand and gravel	8	411
Sand and gravel, clay streaks	9	420
Clay	6	426
Sand and gravel	10	436
Sand and gravel, hard streaks	4	440
Sand and gravel	14	454
Clay, sand, and gravel streaks	5	459
Sand and gravel	5	464
Clay, sand, and gravel streaks	6	470
Clay, red	14	484
Sand and gravel, hard streaks	6	490
Sand and gravel	50	540
Sand and gravel, clay streaks	30	570
Sand and gravel	30	600
Sand and gravel, clay streaks	7	607
Clay	3	610
Clay, red and white, sand and gravel streaks	5	615
Clay, red and white	14	629
Sand and gravel	3	632
Sand and gravel, clay streaks	3	635
Clay	2	637
Sand and gravel	8	645
Sand, gravel, and some clay	10	655
Clay, soft, some sand and gravel	3	658
Sand and gravel, hard	2	660
Clay, soft	2	662
Sand and gravel	8	670
Sand and gravel, hard streaks	5	675
Sand and gravel, soft	5	680
Sand and gravel, hard streaks	20	700
Sand, soft	4	704
Sand and gravel, hard streaks	4	708
Sand and gravel, soft	10	718
Sand and gravel, hard	2	720
Sand and gravel, soft	5	725
Clay, sand, and gravel streaks	5	730
Sand and gravel, soft; contains a little clay	10	740
Sand and gravel, hard	6	746
Sand, gravel, and clay streaks	14	760
Sand and gravel, hard streaks	5	765
Sand and gravel, red clay streaks	5	770
Sand and gravel, soft	5	775
Sand, gravel, and clay streaks	25	800
Sand and gravel, hard	5	805
Sand, gravel, and clay streaks	5	810

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 11.3.23.121 (continued)		
Santa Fe group (continued)		
Sand and gravel	4	814
Clay	2	816
Sand and clay	4	820
Clay	4	824
Sand and gravel	6	830
Sand, gravel, and clay streaks	5	835
Clay, streaks of sand and gravel	5	840
Sand, gravel, and clay streaks	10	850
Sand and gravel	8	858
Sand and gravel, hard	2	860
Sand and gravel	3	863
Clay	6	869
Sand and gravel	1	870
Sand, gravel, and clay streaks	10	880
Clay, sand, and gravel streaks	15	895
Clay	17	912

Well 11.4.19.144 Driller's log of Norrins Realty Co. oil test

	Thickness (feet)	Depth (feet)
Bajada deposits and Santa Fe group:		
Surface soil	6	6
Gravel	8	14
Sand	12	26
Boulders	52	78
Sand, coarse	22	100
Boulders	38	138
Sand, fine	12	150
Gravel, cemented, hard	10	160
Sand and gravel, soft	45	205
Gravel, cemented, arkosic	5	210
Sand, soft	10	220
Arkose	5	225
Sand, soft	5	230
Arkose	20	250
Santa Fe group:		
Arkose, very hard	100	350
Sand, soft; water stands at 350 feet	10	360
Granite wash, hard	55	415
Sand, soft	27	442
Granite wash, hard	8	450
Gravel, coarse	10	460
Arkose	40	500
Arkose, very hard	50	550
Arkose, very hard, with thin strata of red shale	50	600

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 11.4.19.144 (continued)		
Santa Fe group (continued)		
Shale, gray and red	20	620
Gravel, coarse, hard, cemented	30	650
Shale, red and gray	50	700
Arkose, hard	50	750
Shale, gray	10	760
Sand, white, hard	40	800
Arkose, very hard	20	820
Arkose, very hard, with red and gray shale breaks	30	850
Shale, red and gray	100	950
Sand and gravel, coarse; water-bearing	10	960
Shale, brown	40	1,000
Quicksand	50	1,050
Sand and gravel	50	1,100
Shale, brown	50	1,150
Sand, soft	25	1,175
Gravel, coarse	25	1,200
Lime, white	10	1,210
Shale, brown	40	1,250
Sand and gravel	50	1,300
Shale, brown	10	1,310
Gravel, coarse	15	1,325
Sand	50	1,375
Gravel, coarse	50	1,425
Shale, brown	35	1,460
Lime, gray	13	1,473
Sand, fine	77	1,550
Shale, gray and red	50	1,600
Sand	25	1,625
Gravel, coarse	50	1,675
Granite boulders	15	1,690
Granite wash, hard, coarse	10	1,700
Granite wash, hard	50	1,750
Sand, soft	25	1,775
Boulders	25	1,800
Granite wash	50	1,850
Shale, red	25	1,875
Shale, gray	50	1,925
"Graphite wash" [biotite sand? or granite wash?]	10	1,935
Boulders, granite	15	1,950
Shale, brown	10	1,960
Lime, hard	15	1,975
Lime, gray	25	2,000
Shale, red	25	2,025
Boulders, granite, hard	75	2,100

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 11.4.19.144 (continued)		
Santa Fe group (continued)		
Granite wash	50	2,150
Shale, gray	10	2,160
Sand, gray, hard	20	2,180
Shale, gray	165	2,345
Sand, gray, hard	65	2,410
Shale, gray, soft	140	2,550
Shale, gray, hard	100	2,650
Sandstone, gray, hard	50	2,700
Sand, gray, hard	50	2,750
Sand, gray, soft	50	2,800
Sand, gray, hard	50	2,850
Shale, gray	40	2,890
Sand, gray, soft; water	112	3,002
Sand, gray, soft	108	3,110
Sand, soft	8	3,118
Shale, gray	100	3,218
Sand, gray, very hard, sandstone	82	3,300
Sand, gray, soft	50	3,350
Sand, soft	50	3,400
Lime, gray, sandy, very hard	45	3,445
Lime, gray, sandy, hard	35	3,480
Shale, gray	120	3,600
Lime shell [?]	10	3,610
Shale, pink	30	3,640
Sand, gray, hard	10	3,650
Sand, gray	50	3,700
Sand, gray, hard	80	3,780
Shale, gray	30	3,810
Sand, gray, soft	10	3,820
Sand, gray, hard	140	3,960
Sand, gray, soft	60	4,020
Shale, brown	20	4,040
Sand, gray, hard	60	4,100
Sand, black, soft	200	4,300
Sand, black and gray, hard	100	4,400
Sand, gray, hard	60	4,460
Sand, dark-gray, hard	20	4,480
Sand, gray, hard	120	4,600
Sand, gray, sticky	110	4,710
Sand, gray, hard	66	4,776
Shale, gray, sticky	4	4,780
Sand, gray, hard	15	4,795
Shale, gray	15	4,810
Sand, gray, hard	12	4,822
Sand, gray, hard, with strata of sticky shale	48	4,870

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 11.4.19.144 (continued)		
Santa Fe group (continued)		
Shale, gray	60	4,930
Shale, gray, hard	20	4,950
Sand, gray, soft	20	4,970
Shale, gray, sticky	10	4,980
Sand, gray, soft	44	5,024

Well 12.4.32.242 Driller's log of stock well

	Thickness (feet)	Depth (feet)
Bajada deposits and Santa Fe group[?]:		
Soil with large boulders	68	68
Rock, possibly extra large boulder	4	72
Clay, sandy	36	108
Sand, hard, packed	48	156
Clay, sandy	72	228
Gravel, coarse	17	245
Boulders, closely packed	7	252
Clay, sandy	88	340
Sand and gravel, loose	36	376
Sand, hard, possibly soft sandstone	1	377
Sand, loose	73	450
Santa Fe group:		
Talc [probably caliche or hard clay]	3	453
Gravel and clay in layers	82	535
Sand, loose	13	548
Sand, gravel, and clay in layers	50	598
Sand, loose	10	608
Gravel, coarse; water-bearing	8	616
Sand and gravel, coarse	12	628

Well 13.3.3.223 Driller's log of stock well

	Thickness (feet)	Depth (feet)
Santa Fe group:		
Top soil	10	10
Sand, brown	20	30
Gravel	20	50
Sand, brown	80	130
Sandstone	10	140
Sand, gray	40	180
Clay, yellow, sandy	5	185

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 13.4.1.234 Driller's log of industrial and irrigation well		
Alluvium:		
Soil, sandy, loose	16	16
Clay, sandy, brown	6	22
Sand and gravel, small; water-bearing	7	29
Clay, gray	6	35
Gravel and boulders; water-bearing	12	47
Clay, grayish-black, sticky	1	48
Gravel and large boulders; water-bearing	18	66
Clay and gravel, conglomerate, red	8	74
Sand and gravel, coarse, gray; water-bearing	34	108
Santa Fe group:		
Clay, red, sandy	2	110
Clay, gray, soft	8	118
Sand and gravel, coarse, gray; water-bearing	31	149
Clay, red-cream	9	158
Sand, gray; water-bearing; gravel appeared in this strata at 164 feet and continued to 175 feet	17	175
Clay, light-gray, some white	2	177
Sand and gravel, gray; water-bearing	15	192
Sand, gray, soft, cemented	1	193
Clay, gray, soft	2	195
Sand and gravel, gray; water-bearing	19	214
Clay, brown, dense	2	216
Sand and gravel, coarse, gray; yields much water	22	238
Clay, red	5	243
Sand, hard, cemented	2	245
Clay, gray	4	249
Clay, red and gray; appears to effervesce in water	8	257
Sand, gray; water-bearing; clay sloughing from above makes the 260 feet sample impure	7	264
Sand and gravel, gray; water-bearing	4	268
Sand, gray to black, very tight	10	278
Clay, red and gray; caving	6	284
Clay, sand, hard-packed, red to gray streaks	14	298
Sand and gravel, gray, tight; contains thin streaks of light-brown clay	27	325
Sand and gravel, cemented; streaks of hard brown clay; conglomerate bed at 330 feet	24	349
Sandstone conglomerate, gray and light-green	6	355
Clay, packed, white and brown	11	366
Sand and gravel, coarse, gray; water-bearing	15	381
Sandstone, light-green, and conglomerate	8	389
Sand and gravel, coarse, gray; yields much water	6	395

TABLE 5 (continued)

	Thickness (feet)	Depth (feet)
Well 13.4.1.234 (continued)		
Santa Fe group (continued)		
Clay, red, sandy	6	401
Sand and gravel, coarse, gray; yields much water	2	403
Clay and gravel conglomerate, brown	3	406
Sand and gravel, coarse, gray; gravel predominates in top 2 feet and grades to coarse sand	17	423
Clay and gravel conglomerate, red to brown	3	426
Gravel, hard, cemented	9	435
Sand and gravel, coarse, gray; yields much water	4	439
Sand and clay, brown, tight, and lightly cemented sand	9	448
Sand and gravel, coarse, gray; yields much water	18	466
Sandstone, gray, silty	1	467
Sand and gravel, gray; gravel appeared at 474 feet; water-bearing	16	483
Gravel, hard, cemented, dry; strata is very "light"[?]; largest gravel 3 to 4 inches in diameter	10	493
Sand, gray; yields much water	48	541
Clay, red, sandy	2	543
Clay, gray, bentonite, very slick[?]	2	545
Sandstone, brown, hard	5	550

TABLE 6

CHEMICAL ANALYSES OF WATER FROM SELECTED WELLS AND SPRINGS IN THE ALBUQUERQUE AREA, BERNALILLO AND SANDOVAL COUNTIES, N. MEX.

(Analyses by U. S. Geological Survey. Chemical constituents unless otherwise indicated are in parts per million. Values reported for dissolved solids are calculated from determined constituents.)

Stratigraphic unit: p€, Precambrian rocks; QTs, Santa Fe group; Qal, alluvium.

Location number	Owner or name	Date collected	Strati-graphic unit	Temperature (°F)	Silica (SiO_2)	Iron (Fe) Total	Iron (Fe) In solution	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Parts per million	Dissolved solids: Tons per acre-foot	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Sodium-adsorption ratio (SAR)	Specific conductance (micromhos at 25°C)	pH	Reference to tables of well records
8.1W.24.312	Isleta Pueblo	6- 4-56	QTs	71	29	-	-	49	15	114		86	0	292	37	0.5	4.4	-	583	0.79	184	114	57	3.6	869	7.8	Table 4
8.2W.12.111	Laguna Pueblo	4-29-57	Qal(?)	62	16	-	-	145	43	1,050		677	0	1,900	198	2.0	1.2	-	3,690	5.02	539	0	81	20	4,910	7.4	Do.
24.131	Isleta Pueblo	5-28-57	QTs	64	13	-	-	333	143	830		274	0	2,200	500	.8	3.3	-	4,160	5.66	1,420	1,190	56	9.6	5,290	7.3	Do.
9.1W. 4.424	G. T. Hill	4-19-57	Qal(?)	60	20	-	-	262	100	281		346	0	1,280	36	.7	7.3	0.67	2,160	2.94	1,060	781	36	3.7	2,670	7.3	Do.
10.114	A. A. Archuleta	11-17-54	QTs	64	23	3.3	0.01	-	-	325		408	0	1,040	24	.2	.2	-	-	-	745	440	49	5.2	2,490	-	Do.
11.1W.11.424	S. Angell	4-23-57	QTs	65	25	-	-	23	5.5	57		159	0	49	10	.6	7.3	-	255	.35	80	0	61	2.8	397	7.6	Do.
28.224	do.	4-23-57	Qal(?)	55	59	-	-	34	8.1	33		154	0	46	10	1.0	.6	-	268	.36	118	0	38	1.3	371	7.5	Do.
12.1W.14.114	F. Bond and Son, Inc.	4-24-57	Qal(?)	66	41	-	-	66	13	25		206	0	79	15	.2	.4	-	341	.46	218	49	20	7.7	514	7.8	Do.
35.234	Benavidez Ranch	4-23-57	QTs(?)	66	22	-	-	2.4	1.2	95		184	7	33	8	-	10	-	269	.37	11	0	95	12	410	8.6	Do.
13.1W.22.421	F. Bond and Son, Inc.	12- 56	Qal	-	-	-	-	490	919	5,960		259	0	16,500	125	-	182	-	24,600	33.5	5,000	4,790	72	37	22,600	7.8	Do.
8. 1. 1.342	Isleta Pueblo	8-28-57	QTs	68	44	-	-	27	6.9	66		145	0	96	12	1.2	.7	-	325	.44	96	0	60	2.9	475	8.1	Do.
8. 2. 1.312	R. Ward	10- 2-56	Qal	57	-	-	-	-	-	-		164	0	95	14	-	-	.03	-	-	202	88	-	-	499	7.6	Table 3
29.213	Isleta Pueblo	4-29-57	QTs	86	52	-	-	23	6.6	65		178	0	46	20	1.2	.4	-	302	.41	84	0	63	3.1	470	7.9	Table 4
8. 3.14.231	do.	3-22-56	QTs	72	-	-	-	-	-	-		139	0	35	10	-	-	-	-	-	143	29	-	-	355	7.6	Do.
S8. 4. 9.314	Isleta Pueblo (Hubble Spring)	2-27-56	QTs(?)	56	-	-	-	-	-	-		217	0	217	30	-	-	-	-	-	344	166	-		836	7.4	Do.
9. 2. 3.342	E. Snipes	10- 5-56	QTs(?)	68	-	-	-	-	-	-		150	0	77	22	-	-	-	-	-	145	22	-	-	475	7.7	Do.
12.322	Valley Utilities, Inc.	10- 3-56	Qal and QTs	-	-	-	-	-	-	-		259	0	186	24	-	-	.08	-	-	288	76	-	-	823	7.9	Table 2
35.113	U. S. Bureau of Reclamation	10- 2-56	Qal and QTs	62	-	-	-	-	-	-		202	0	133	28	-	-	-	-	-	272	105	-	-	660	7.5	Table 3
9. 3. 1.112	U. S. Government	3-13-57	QTs	63	32	.04	.04	35	7.4	19		136	0	27	14	.3	.0	-	202	.27	118	6	26	.8	319	7.5	Table 2
1.222	do.	3-13-57	QTs	62	28	.00	.00	39	9.5	17		156	0	32	6.8	.3	2.0	-	212	.29	126	8	21	.6	341	7.8	Do.
5.234	State-wide Products Co.	5- 2-57	QTs	69	57	-	-	32	9.3	14		131	0	31	5.5	.6	.1	-	214	.29	118	10	21	.6	296	7.8	Do.
9.113	Public Service Co, Persons Station	5-22-56	QTs	77	69	.05	.05	32	8.6	34		132	0	33	32	.5	.5	.07	275	.37	116	8	39	1.4	389	7.7	Do.
11.241	J. Carter	4-26-57	QTs	67	41	-	-	83	11	28		138	0	46	9	.6	171	-	458	.62	252	139	19	.8	639	7.8	Table 3
19.322	H. Smith	10- 2-56	Qal	66	-	-	-	-	-	-		142	0	29	25	-	-	-	-	-	140	24	-	-	364	7.8	Do.
9. 4. 5.332	U. S. Government	3-13-57	QTs	62	28	.09	.00	69	15	19		204	0	71	15	.2	16	-	333	.45	234	66	15	.5	576	7.7	Table 2
6.411	do.	3-13-57	QTs	58	27	.08	.00	57	13	21		190	0	64	11	.6	2.5	-	289	.39	196	40	19	.7	464	7.6	Do.
20.221	do.	7- 9-59	QTs	73	28	.21	.02	66	19	58		280	0	59	48	1.3	9.9	-	427	.58	244	14	34	1.6	704	7.6	Do.
10. 1.18.331	O. O. Armijo	11-17-54	QTs	64	21	-	-	-	-	40		146	0	34	16	.8	8.4	-	-	-	99	0	47	1.8	364	-	Table 4
30.220	U. S. Government	3-19-55	QTs	-	20	1.9	.00	121	28	178	6.0	108	0	641	23	.6	4.0	-	1,060	1.44	408	320	48	3.8	1,450	7.8	Table 2
10. 2. 2.212	College of St. Joseph	4-26-57	QTs	-	75	-	-	61	18	38		170	0	128	26	.6	2.6	-	434	.59	230	90	26	1.1	614	7.7	Do.
12.412	City of Albuquerque	5-21-57	QTs	70	64	-	-	36	7.6	62		181	0	87	12	.4	.3	-	358	.49	122	0	53	2.5	499	7.7	Table 1
14.211	Gray's Flower Shop and Nursery	4-26-57	QTs	61	51	-	-	58	14	45		172	0	123	20	.4	1.3	.03	398	.54	202	61	32	1.4	583	8.0	Table 3
24.233	City of Albuquerque	5-21-57	QTs	62	62	-	-	33	6.2	56		155	0	78	15	.6	.1	-	327	.44	108	0	53	2.4	454	7.7	Table 1
25.213	do.	5-21-57	QTs	66	60	-	-	33	6.2	81		176	0	111	17	.6	.2	-	396	.54	106	0	62	3.4	556	7.7	Do.
10. 3. 5.444	do.	5-22-57	QTs	60	50	-	-	34	7.6	21		134	0	37	10	.2	.1	-	226	.31	116	6	29	.9	315	7.8	Do.
7.242	U. S. Indian School	5- 1-57	Qal	61	60	-	-	193	57	106		366	0	570	36	.3	.2	-	1,200	1.63	716	416	24	1.7	1,590	7.2	Table 3
8.243	City of Albuquerque	5-21-57	QTs	68	58	-	-	38	8.1	29		145	0	42	19	.4	.2	-	266	.36	128	10	33	1.1	380	7.8	Table 1
8.443a	do.	5-21-57	QTs	68	64	-	-	63	13	41		182	0	110	24	.4	.4	-	405	.55	210	62	30	1.2	585	7.7	Do.
11.244	do.	5-22-57	QTs	63	40	-	-	40	4.8	20		144	0	29	10	.2	.7	-	216	.29	120	2	27	.8	326	7.8	Do.
17.343	Bernalillo County Court House	5- 1-57	QTs	64	61	-	-	110	29	40		228	0	211	52	.4	.1	-	616	.84	394	206	18	.9	889	7.5	Table 2
19.111	Albuquerque Country Club	4-28-57	Qal and QTs(?)	57	33	-	-	63	13	38		189	0	110	16	.4	.3	-	367	.50	210	56	28	1.1	556	7.7	Table 3
20.124a	Hilton Hotel	5- 1-57	QTs	70	75	-	-	46	16	51		174	0	99	32	.6	.1	-	406	.55	181	38	38	1.7	566	7.6	Table 2
20.124b	do.	5- 1-57	Qal	70	73	-	-	89	26	75		250	0	212	46	.6	.2	-	645	.88	329	124	33	1.8	916	7.6	Do.
20.344	A.T. & S.F. RR Co.	5-22-57	QTs	-	81	-	-	30	9.0	41		145	0	48	22	.4	.8	-	303	.41	112	0	44	1.7	405	7.9	Do.
21.433	Albuquerque Board of Education	4-26-57	QTs	-	45	-	-	53	14	21		113	0	94	30	.4	1.3	-	315	.43	190	97	19	.7	467	8.0	Do.

TABLE 6 (continued)

Location number	Owner or name	Date collected	Strati-graphic unit	Temperature (°F)	Silica (SiO_2)	Iron (Fe) Total	Iron (Fe) In solution	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Parts per million	Dissolved solids: Tons per acre-foot	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Sodium-adsorption ratio (SAR)	Specific conductance (micromhos at 25°C)	pH	Reference to tables of well records
10. 3.27.243	City of Albuquerque	5-22-57	QTs	69	52	-	-	36	6.2	24	143	0	30	13	0.4	0.2	-	232	0.32	116	0	31	1.0	325	7.9	Table 1
32.141	do.	5-21-57	QTs	78	73	-	-	17	7.1	54	151	0	33	19	.8	1.3	-	279	.38	72	0	62	2.8	389	8.0	Do.
34.144	U. S. Government	1-10-57	QTs	-	47	0.28	0.01	33	8.1	12	122	0	29	7.5	.3	.0	-	197	.27	116	16	18	.5	284	7.6	Table 2
35.111	do.	7-11-57	QTs	-	38	.01	.00	33	6.6	19	130	0	30	8.5	.4	.2	-	200	.27	110	3	27	.8	292	7.9	Do.
36.132	Veterans Administration Hospital	5-19-56	QTs	68	38	.04	.04	32	6.6	25	134	0	36	8.8	.4	.3	0.06	213	.29	107	0	34	1.0	318	7.8	Do.
10. 4. 3.223	J. Judd	5- 7-56	QTs	-	23	.02	.02	65	10	22	204	0	54	14	1.4	4.8	-	294	.40	203	36	19	.7	466	7.7	Table 4
510. 4.13.242	Embudo Spring	5- 7-56	p€	56	34	-	-	149	31	29	497	0	121	18	1.6	.2	-	628	.85	500	92	11	.6	963	7.7	Do.
10. 4.16.334	City of Albuquerque	5-22-57	QTs	75	29	-	-	28	2.8	29	134	0	20	8	.6	1.5	-	185	.25	82	0	44	1.4	283	7.9	Table 1
20.111	do.	8- 8-58	QTs	71	28	.00	.00	40	1.2	26	131	0	19	22	.5	.6	-	201	.27	105	0	35	1.1	315	7.9	Do.
29.413	U. S. Government	5- 5-55	QTs	71	27	.01	.01	74	14	26	234	0	82	12	.3	4.0	-	354	.48	242	50	19	.7	555	7.6	Table 2
30.321	do.	3-13-57	QTs	58	26	.12	.05	37	7.1	17	149	0	24	7.0	.4	1.7	-	193	.26	122	0	24	.7	310	7.7	Do.
31.411	do.	3-13-57	QTs	58	27	.02	.00	60	11	24	195	0	67	10	.3	2.1	-	297	.40	194	34	21	.7	474	7.7	Do.
32.433	do.	3-13-57	QTs	62	24	.06	.00	71	14	21	212	0	79	12	.2	9.2	-	334	.45	234	61	16	.6	534	7.6	Do.
34.214	Four Hills Country Club	9-27-57	QTs	58	20	-	-	79	22	26	242	0	103	16	.6	17	-	403	.55	288	89	16	.7	636	7.3	Table 3
11. 1.26.424	F. Bond and Son, Inc.	5- 9-56	QTs	-	7.4	-	-	19	2.4	108	40	73	100	22	.8	.3	.22	352	.48	58	0	80	6.2	572	10.1	Table 4
11. 2.22.441	R. E. Hughes	4-25-57	QTs	68	15	-	-	219	58	271	218	0	1,100	31	.6	7.0	-	1,810	2.46	785	606	43	4.2	2,300	7.4	Do.
11. 3. 9.331	C. Bachecbi	10- 2-56	Qal and QTs(?)	57	-	-	-	-	-	-	320	0	196	32	-	-	-	-	-	396	134	-	-	920	7.7	Table 3
10.444	Nazareth Sanatorium	10- 2-56	Qal(?) and QTs	58	-	-	-	-	-	-	372	0	158	15	-	-	.11	-	-	292	0	-	-	874	7.9	Do.
21.132	Ranchos School	11- 8-56	Qal	-	31	.53	.04	124	27	49	382	0	169	26	.6	.1	-	615	.84	420	108	20	1.0	939	7.6	Table 2
23.112	Public Service Co.	4-22-57	QTs	58	28	-	-	23	6.4	228	414	0	231	5.5	1.8	24	-	722	.98	84	0	86	1.1	1,090	7.7	Do.
26.342	A. G. Simms	10-17-56	QTs	61	-	-	-	-	-	-	146	0	49	12	-	-	.04	-	-	158	38	-	-	364	8.2	Table 3
30.341	do.	10- 2-56	Qal and QTs(?)	58	-	-	-	-	-	-	235	0	94	17	-	-	.04	-	-	264	72	-	-	595	7.8	Do.
31.231	City of Albuquerque	5-21-57	QTs	66	67	-	-	30	7.1	23	133	0	31	9	.4	.1	-	233	.32	104	0	33	1.0	308	7.9	Table 1
33.322	Rainbo Baking Co.	5- 1-57	Qal	58	43	-	-	250	51	124	222	0	701	134	.3	2.9	-	1,420	1.93	834	652	25	1.9	1,890	7.5	Table 2
34.141	Mission Avenue Elementary School	5- 1-57	QTs	62	35	-	-	34	9.0	13	126	0	31	9.5	.4	.2	-	194	.26	122	18	19	.5	291	7.7	Do.
911. 4. 1.314	U. S. Forest Service	5- 8-56	p€	63	20	-	-	42	7.4	12	163	0	16	5.5	1.2	.1	-	184	.25	136	2	16	.4	297	7.2	Table 4
11. 4.16.341	J. Santillenea	5- 1-57	QTs	69	26	-	-	43	7.4	17	173	0	21	6.0	.6	.7	-	207	.28	138	0	21	.6	331	7.5	Do.
12. 1.22.222	J. Baylor	4- 6-56	QTs	71	-	-	-	-	-	-	153	0	43	4	-	-	-	-	-	37	0	-	-	373	7.7	Do.
12. 2. 4.242	J. F. Koontz	4- 6-56	QTs	74	-	-	-	-	-	-	140	0	48	6	-	-	-	-	-	68	0	-	-	370	7.6	Do.
12. 3.26.112b	Sandia View Academy	5- 1-57	Qal	-	26	-	-	44	12	17	137	0	60	14	.4	.1	-	240	.33	160	47	18	.6	380	7.6	Do.
27.222	do.	5- 1-57	QTs or Qal	59	34	-	-	115	22	58	384	0	147	17	.4	15	-	597	.81	378	63	25	1.3	906	7.5	Table 2
35.243	U. S. Bureau of Reclamation	5- 8-58	Qal	51	24	.01	.01	63	10	38	191	0	94	18	.1	.3	.10	342	.47	198	42	30	1.2	521	7.8	Do.
12. 4. 6.213	Town of Bernalillo	5- 1-57	QTs	64	63	-	-	37	11	56	168	0	53	46	.8	.5	-	350	.48	138	0	47	2.1	501	7.8	Table 1
17.424	Sandia Pueblo	5- 7-56	QTs	68	47	.06	.06	40	5.9	24	142	0	39	12	.6	.7	.06	239	.33	124	8	29	.9	329	7.9	Table 4
30.124	do.	5- 7-56	QTs	63	35	.01	.01	70	19	36	212	0	84	44	.4	8.4	.12	401	.55	252	79	24	1.0	631	7.8	Do.
32.242	do.	5- 7-56	QTs	85	48	-	-	73	15	56	184	0	63	105	.2	.4	-	451	.61	244	92	33	1.6	735	7.7	Do.
35.231	Mrs. Venegas	9-21-50	p€	-	21	-	-	76	17	36	286	-	71	9	4.0	8.8	-	384	.52	260	25	7	1.0	616	-	Do.
13. 3. 3.223	Bureau of Land Management	1-18-57	QTs	61	36	-	-	81	19	44	128	0	169	32	.8	59	-	504	.69	280	175	25	1.1	736	7.4	Do.
25.244	Pilgrim Indian School	5- 8-56	QTs	-	41	.01	.01	202	30	137	110	0	339	355	.6	14	.41	1,140	1.55	628	538	32	2.4	1,830	7.6	Do.
13. 4. 1.233	El Yeso Liquor Store	7-28-52	Qal	-	42	-	-	281	55	123	187	0	887	71	.4	20	-	1,570	2.14	927	774	22	1.8	1,940	7.7	Do.
1.234	Plains Electric Coop., Inc.	4-19-53	QTs	-	97	-	-	108	24	114	590	0	55	53	.2	.4	-	742	1.01	368	0	40	2.6	1,090	-	Table 2

TABLE 6 (continued)

Location number	Owner or name	Date collected	Strati-graphic unit	Temperature (°F)	Silica (SiO_2)	Iron (Fe) Total	Iron (Fe) In solution	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Parts per million	Dissolved solids: Tons per acre-foot	Hardness as $CaCO_3$: Calcium magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Sodium-adsorption ratio (SAR)	Specific conductance (micromhos at 25°C)	pH	Reference to tables of well records
13. 4. 1.243	Plains Electric Coop., Inc.	5-11-53	QTa	-	74	-	-	167	38	142		488	0	384	55	0.5	2.5	-	1,100	1.50	572	172	35	2.6	1,520	-	Table 2
1.412	do.	11- 7-52	QTs	-	72	-	-	125	29	92		353	0	284	32	.4	1.4	-	810	1.10	431	142	32	1.9	1,120	-	Do.
1.432	Ben Meyars	7-26-52	Qal(?)	-	31	-	-	-	-	-		148	0	-	-	-	-	-	-	-	138	-	-	-	361	7.8	Table 4
11.113	John Stone	7-26-52	Qal	-	68	-	-	101	25	184		632	0	171	39	.6	2.2	-	902	1.23	355	0	53	4.2	1,320	7.3	Do.
29.421	Southern Union Gas Co.	7-26-52	Qal	-	91	-	-	30	6.1	81		226	0	46	28	1.4	.5	-	395	.54	100	0	64	3.5	524	7.6	Table 2
30.231	Coronado State Monument	9-19-57	QTs	54	52	1.2	.04	105	29	128		125	0	148	285	.6	.1	-	808	1.10	381	278	42	2.8	1,340	7.6	Table 4
14. 2. 5.320	Zia Pueblo	4-18-57	QTs	58	18	-	-	48	11	13		132	0	29	3	.4	62	-	249	.34	165	57	15	.4	389	7.8	Do.
23.321	do.	4-18-57	QTs	-	-	-	-	-	-	-		134	0	88	110	-	-	-	-	-	134	24	-	-	783	7.4	Do.
14. 3.18.340	do.	4-18-57	QTs	62	32	-	-	248	49	219		191	0	449	475	.0	3.4	-	1,570	2.14	820	664	37	3.3	2,570	7.3	Do.

TABLE 7

CHEMICAL ANALYSES OF WATER FROM STREAMS AND DRAINS IN THE ALBUQUERQUE AREA, BERNALILLO AND SANDOVAL COUNTIES, N. MEX.

(Analyses by U. S. Geological Survey. Values reported for dissolved solids are calculated from determined constituents. Chemical constituents unless otherwise indicated are in parts per million.)

Location number	Name of station	Date collected	Temperature (°F)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids		Hardness as $CaCO_3$		Percent sodium	Sodium adsorption ratio (SAR)	Specific conductance (micromhos at 25° C)	pH	Remarks
															Parts per million	Tons per acre-foot	Calcium, Magnesium	Noncarbonate					
8. 2.26.234	Isleta Riverside Drain at Isleta	3-20-52	-	-	71	16	39	-	-	-	-	-	-	0.17	-	-	243	-	26	1.1	599	-	
10. 2.13.432	Rio Grande at Albuquerque	10- 37	-	-	62	11	49	166	0	127	26	-	-	-	-	-	200	62	35	1.5	593	-	Composite sample Oct. 11, 13-20, 1937.
13.432	do.	6- 36	-	-	24	6.6	-	-	-	34	35	-	-	-	-	-	87	-	-	-	205	-	Composite sample June 1-10, 1936.
13.441	Alameda Interior Drain at outlet in Albuquerque	11-30-51	-	-	102	16	67	302	0	172	26	-	-	-	607	0.83	320	73	31	1.6	854	-	Dissolved solids is residue on evaporation.
10. 3. 9.234	Embudo Arroyo at bridge on State Highway 422 at Albuquerque	5- 6-57	-	-	-	-	4.5	161	0	-	-	-	-	-	-	-	162	6	6	.2	318	7.2	
11. 3. 3.112	Corrales Interior Drain below Corrales	5-28-57	68	28	103	16	46	315	0	136	17	0.6	0.2	-	508	.69	323	65	25	1.2	780	7.6	
26.443	Bear Arroyo at bridge on State Highway 422 near Albuquerque	6-17-57	71	9.5	-	-	2.4	100	0	-	0	-	-	-	-	-	76	0	6	.1	164	7.6	
12. 3.23.422	Albuquerque Riverside Drain at head near Sandia Pueblo	2- 4-52	-	-	56	10	36	-	-	-	-	-	-	.05	-	-	186	-	28	1.1	510	-	
35.111	Corrales Interior Drain near head near Corrales	5-26-57	-	26	101	14	44	315	0	122	13	.4	1.0	-	479	.65	310	52	24	1.1	727	7.5	
15. 1.12.243	Rio Salado at bridge on State Highway 44 at San Ysidro	4- 2-45	-	-	406	104	3,740	356	15	4,880	2,970	-	-	>10	12,300	16.7	1,450	1,130	85	43	15,900	-	
15.1W.10.214	Rio Salado 2 miles upstream from bridge on State Highway 44, near San Ysidro	6-14-46	-	34	44	7.6	46	177	0	47	36	1.0	.2	.20	306	.42	141	0	43	1.6	429	-	

TABLE 8

COMMON CHEMICAL CONSTITUENTS AND CHARACTERISTICS OF WATER AND SUMMARY OF ANALYSES OF WATER IN THE ALBUQUERQUE AREA, BERNALILLO AND SANDOVAL COUNTIES, N. MEX.

[Derivation, significance, and recommended limits are mostly those set forth by the California State Water Pollution Control Board (1957). Constituent has no harmful physiological effect, unless specified.]

Constituent or property	Derivation	Significance	Recommended limits for selected uses	Range in concentration for samples analyzed	Number of determinations	Number of determinations more than (>) or less than (<) selected concentrations
Silica (SiO_2)	Siliceous materials present in virtually all rocks.	Forms hard scale in boilers and pipes. Inhibits deterioration of zeolite-type water softeners. May prevent corrosion in pipes by forming a protective coating.	1 ppm for high-pressure-boiler feed. 10 to 50 ppm for other industrial processes.	7.4 to 97 ppm	64	26 > 50 ppm
Iron (Fe)	Iron-bearing minerals present in most rocks. Iron may be added to water in contact with iron objects such as well casing pipes, and storage tanks.	Oxidizes to a reddish-brown precipitate. More than about 0.3 ppm stains laundry and utensils. Objectionable for many industrial, food-processing, and beverage uses. Supports growth of certain bacteria. Imparts objectionable taste when greater than about 1.0 ppm.	Traces for electroplating. Less than 1.0 ppm for most industrial use. 0.3 ppm for the sum of iron and manganese in domestic supplies.	0.00 to 3.3 ppm	23	7 > 0.1 ppm 4 > 0.3 ppm 3 > 1.0 ppm
Calcium (Ca)	Limestone, dolomite, gypsum or gypsiferous shale, sewage, and industrial waste.	With magnesium causes most of the hardness and scale-forming properties of water. Beneficial in irrigation water where unfavorable sodium ratio exists in soil.	5 ppm for boiler feed.	2.4 to 490 ppm	87	11 > 150 ppm 5 > 250 ppm
Magnesium (Mg)	Dolomite and most igneous rocks.	Similar to calcium in flocculating soil colloids, imparting the property of hardness, and forming scale. Salts of magnesium act as cathartics.	125 ppm for drinking and culinary waters.	1.2 to 919 ppm	87	8 > 50 ppm 2 > 125 ppm
Sodium (Na) plus potassium (K)	Feldspars, salt beds, and other common minerals and sewage and industrial wastes.	Causes foaming in boilers when concentration of sodium plus potassium exceeds 50 ppm. High concentrations are toxic to plants, harmful to soil, and will act as cathartic. High ratio of sodium to calcium-magnesium is harmful to soil structure.	50 ppm of sodium plus potassium for boiler water. 115 ppm sodium maximum for domestic use.	12 to 5,960 ppm	87	16 > 115 ppm 9 > 200 ppm
Bicarbonate (HCO_3) and carbonate (CO_3)	Carbonate rocks and calcareous materials.	In combination with calcium and magnesium forms scale and releases corrosive carbon dioxide gas. A high ratio of carbonate and bicarbonate to alkaline earths may cause the water to be unsuitable for irrigation.	100 ppm for boiler use.	40 to 677 ppm	103	18 > 300 ppm 7 > 400 ppm 2 < 100 ppm
Sulfate (SO_4)	Gypsum, anhydrite, pyrite, and oxidized organic matter in the sulfur cycle.	In combination with calcium and magnesium forms hard scale. As magnesium or sodium sulfate acts as a cathartic. High concentrations may be toxic to plants.	250 ppm for domestic use. 250 ppm in carbonated beverages.	16 to 16,500 ppm	101	16 > 250 ppm 11 > 500 ppm 7 > 1,000 ppm
Chloride (Cl)	Most rocks and soils, sewage, and industrial effluents.	High concentrations of chloride salts impart salty taste. May be toxic to plants. May accelerate corrosion in pipes.	250 ppm for domestic use. 200 ppm for kraft paper pulp.	0 to 2,970 ppm	102	10 > 100 ppm 5 > 250 ppm
Fluoride (F)	Fluorite, apatite, and hydrothermal solutions.	Reduces incidence of tooth decay in children when concentration is 0.5 to 1.5 ppm; more than about 1.5 ppm causes mottling of tooth enamel in children. Concentrations of more than 5 ppm may cause fluorosis.	1.5 ppm for domestic use. 1.0 ppm for food canning.	0.0 to 4.0 ppm	81	10 > 1.0 ppm 4 > 1.5 ppm
Nitrate (NO_3)	Decayed organic matter, sewage, nitrate fertilizers, and nitrates in the soil.	Values higher than 5 to 10 ppm may suggest pollution. More than about 44 ppm may cause methemoglobinemia (infant cyanosis). Generally nitrate in water used for irrigation is desirable for its fertilizing value.	44 ppm for domestic use.	0.0 to 482 ppm	83	10 > 10 ppm 4 > 40 ppm
Boron (B)	Tourmaline, igneous activity, and evaporite deposits.	Traces necessary for good plant growth, larger amounts toxic to plants.	0.33 ppm for plants having a low tolerance for boron.	0.03 to > 10 ppm	18	3 > 0.33 ppm
Dissolved solids	Rocks, soils, industrial and sewage effluents.	High concentrations are harmful to plant and animal life and can cause foaming in boilers.	1,000 ppm for domestic use, although more saline waters are used by some communities without harmful effects. 1,000 ppm for most industrial uses.	184 to 24,600 ppm	83	57 < 500 ppm 12 > 1,000 ppm
Hardness (as $CaCO_3$)	Mainly calcium and magnesium in solution. Certain other cations cause hardness but are ordinarily present in small amounts.	Hard water causes excessive soap consumption, scale in boilers and pipes, toughening of cooked vegetables. Tends to prevent corrosion of metals. Produces finer grained structure in baking. Very hard water retards fermentation.	Water having a hardness of more than 100 ppm generally considered to be hard. 0 to 50 ppm for laundering. 80 ppm for boiler feed water at 0 to 150 pounds per square inch.	11 to 5,000 ppm	106	13 > 500 ppm 80-100 to 500 ppm 13 < 100 ppm
Sodium-adsorption ratio (SAR)	Relative proportion of sodium to calcium and magnesium in water	Index of sodium hazard in irrigation water. An increase in value indicates a decrease in suitability of water for irrigation.	Less than 3 ppm usually satisfactory on all soils. More than 26 ppm generally unsatisfactory.	0.1 to 43 ppm	90	2 > 26 ppm 4 > 10 ppm 7 > 5 ppm 74 < 3.0 ppm
Specific conductance (micromhos at 25°C)	Ion concentration in water.	An increase in value indicates an increase in dissolved solids.	More than 1,500 ppm generally exceeds standards for domestic water. More than 3,000 ppm unsuitable for irrigation under most conditions.	184 to 22,601 ppm	106	19 > 1,000 ppm 13 > 1,500 ppm 4 > 3,000 ppm 47 < 500 ppm
pH (hydrogen ion concentration expressed as pH)	Hydrogen-ion concentration.	Values from 1 to 7 ppm indicate decreasing acidity of more than 7 ppm indicate increasing alkalinity. Affects taste, corrosivity, and treatment processes such as coagulation. Low values desirable where irrigation water applied to alkaline soils	7.5 ppm for food canning and freezing. More than 9.0 ppm unsuitable for irrigation use.	7.2 to 10.1 ppm	93	1 > 9.0 ppm 4 > 8.0 ppm 13 < 7.5 ppm

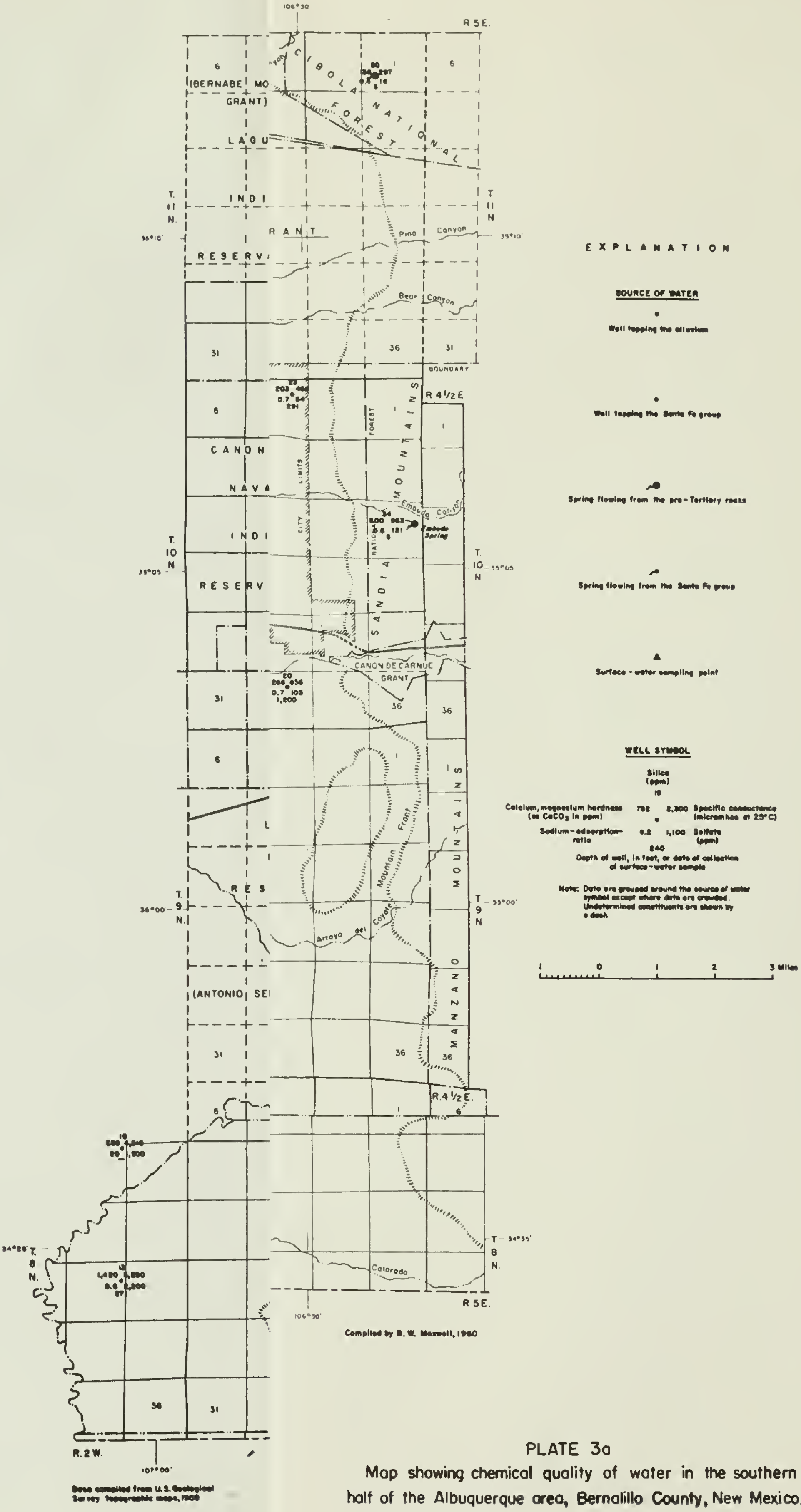
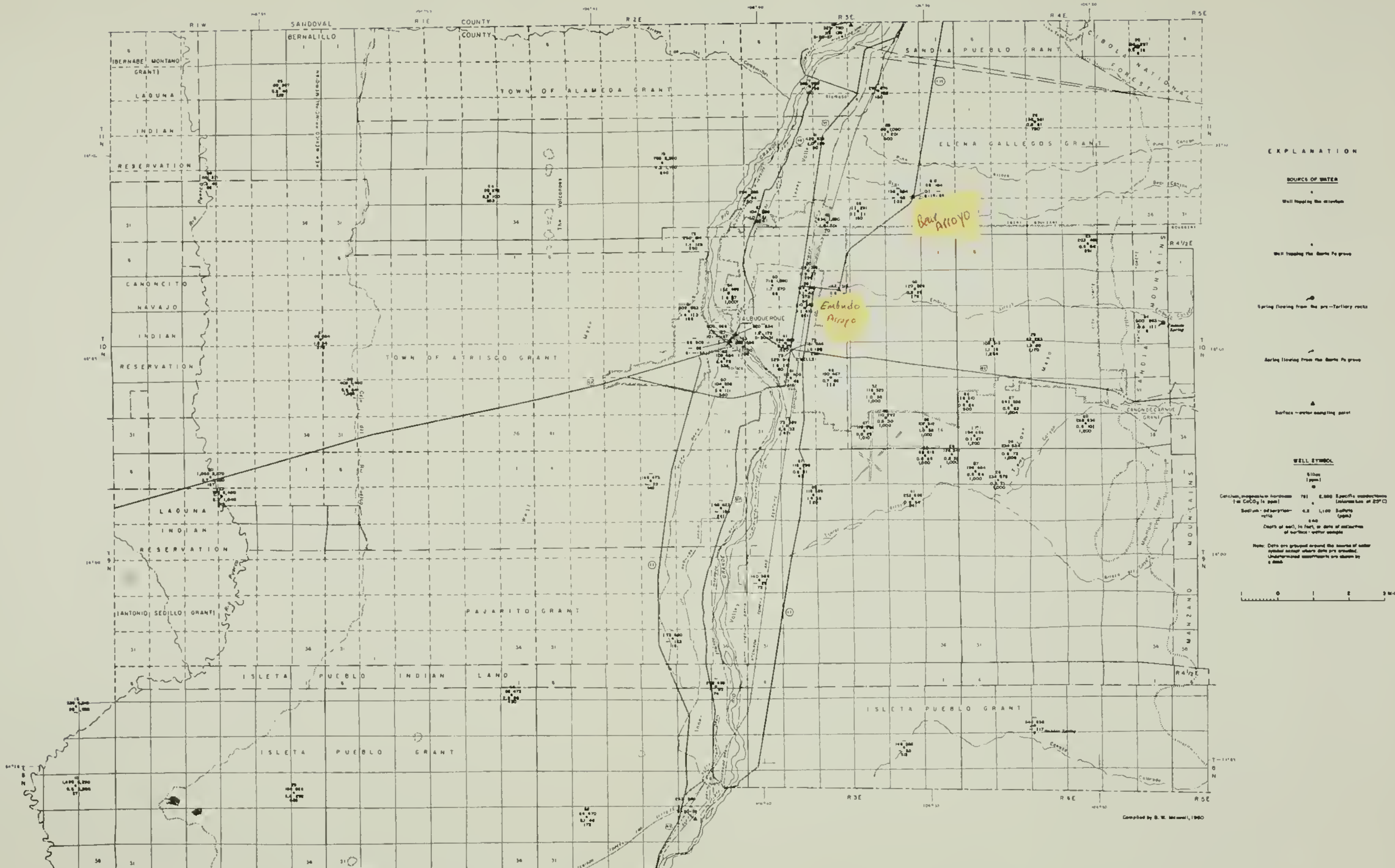


PLATE 3a

Map showing chemical quality of water in the southern half of the Albuquerque area, Bernalillo County, New Mexico.



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